AIR
DEFENSE
PRODUCTION
NUMBER

JUNE
1941

AVIATION

The Oldest American Aeronautical Magazine

McGraw-Hill Publishing Company, Inc.

Price 35c. per copy 40c. in Canada

Next stop...England 2,200 miles away

Time is precious when democracy is at stake Shipment of planes is too slow too uncertain Dismantling and reassembly of planes waste time Now, new planes are being ferried to England They are ready for service on arrival Later, who knows, they may be ferried to South American ports, Hawaii, the Philippines, Australia Far different from the spectacular achievements of Alcock and Brown, Lindbergh, Chamberlin, Kingsford-Smith, and others, are these unheralded flights today

But aircraft engines today are better, more reliable Horsepower per pound of weight has been increased by engine designer and parts manufacturer Twenty years ago a 50-hour full-throttle block test was standard for aviation engines Then Thompson developed silicon-chromium valves which boosted these full-throttle block tests from 50 to 300 hours Today, Thompson sodium-cooled aviation valves often serve efficiently for 4,000 hours and over, before replacement is necessary New types of Thompson fuel and booster pumps are helping bombers and pursuit ships climb to higher altitudes

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Above right: Baker Trucks picking up one of hundreds of heavy dies used in North American's drop-hammer department.

Below: Aerial view of North American Aviation's huge Inglewood, California factory. Vast areas and heavy handling operations of aircraft plants emphasize the need for Baker Trucks

● Geared for highest efficiency in turning out fighting planes for the United States and Great Britain, the huge modern plant of North American Aviation, Inc., at Inglewood, California, uses every available means for stepping up production. Baker Trucks are called into service in the busy drop-hammer department, where they make short work of removing and installing heavy dies, carrying them rapidly to and from the outside storage area.

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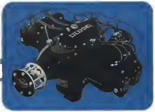

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Very truly yours,

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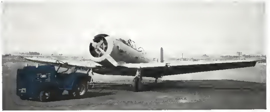

Saving time and money at the airports

"Clarktor 6" Tractor at North American Aviation's Inglewood Calif field tows ships swiftly about the port berths them neatly in hangars.

"CLARKS" speed aircraft production

"Clarks" cut plane production time by the rapid movement of materials and parts—fork trucks for vertical movement, tractors for long horizontal movement At the airports, tractors move planes about deftly and at low operating cost All "Clarks" are gas-powered for 24-hr continuous service Write for Fork Truck and Tractor Bulletins.

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ALUMINUM, DEFENSE, AND YOU

ALCOA

3

IT IS EASY TO UNDERSTAND ABOUT ALUMINUM AND DEFENSE

THE WHOLE THING BOILS DOWN to two simple questions

1. **How much aluminum** are America and England going to need?
   There is only one answer The democracies must have *all the aluminum it takes to win*, and nobody knows how much that is
2. **How fast** is aluminum needed?
   We don't know, for sure, but just as fast as the aircraft plants munition plants, shipyards, and the like, can be expanded to use aluminum and other materials for defense purposes

THOSE IN AUTHORITY IN WASHINGTON are putting together, day by day, expert estimates of what all these defense industries are going to need, month by month, clear to the end of 1942 These estimates as issued, are our book of rules

FOR MONTHS WE HAVE BEEN, and are now delivering aluminum for defense purposes far in excess of that called for by prior estimates

DEFENSE IS NOW TAKING from us over 40 million pounds a month Every American ought to have a picture of just how much aluminum that is, here it is

> Peace time America, during the nine years from 1930-8, could find use for only 14 million pounds a month from us
>
> In the busy year of 1939 we had to make only 27 million pounds a month to satisfy the civilian needs of this prospering country
>
> Suddenly, defense alone needs 40 million a month! 14 million (civilian), to 27 (civilian), to 40 (defense) and soon to 50 and beyond!

* * * *

YOU CIVILIAN USERS of aluminum are grand people

THE WAY YOU ARE DOING WITHOUT aluminum until producers can catch up again with civilian uses is typically American We are sincerely grateful for your understanding

IN THIS RECESS you are having to scramble for **RECESSITIES**—other materials which just don't fill the bill 100%, because there is no pat substitute for aluminum

IT'S TOUGH ON YOU and it's hard on us to have to turn away temporarily from the friends and pursuits of a lifetime

WE HAVE NOT TURNED OUR BACKS!

WE INTEND that no civilian shall have to forego the things aluminum can do best one minute longer than we can help

ALUMINUM COMPANY OF AMERICA

THE *Lockheed* LOG

LEADERSHIP *in service!*

LOCKHEED SERVICE

All Lockheeds . . . of new design or old . . . commercial or military . . . are built with the same inherent stability . . . the same rugged dependability . . . and the same quality of stamina that provide continuous and lasting service with minimum maintenance costs . . . fewer overhauls.

Lockheed airline transports have an outstanding record of steady and efficient performance, under every and all conditions, from the arctic to equatorial jungles. Lockheed Hudson Bombers have distinguished themselves in the skies over Europe by taking unbelievable punishment and bringing their crews home safely . . . and the Lockheed Lightnings have proved themselves capable of meeting the toughest requirements of the United States Army for interceptor pursuits.

But "Serviceability" the way Lockheed supplies it doesn't mean just long life. It means airplanes that see duty month after month, year after year, yet still remain comparable in performance and design to newer models.

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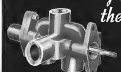

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ANNUAL PRODUCTION ISSUE

The New Airplanes

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JAMES H. McGRAW, Founder and Honorary Chairman

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Chicago, 520 North Michigan Ave. San Francisco, 68 Post Street
Los Angeles, 3121 Dalton Ave. Aldwych, London W. C. 2
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FLASHES

picked up along the editorial airways

Aircraft Production Exceeds Expectations

» THE TIME HAS COME again for us to report more fully on the progress of the air defense program and to look ahead. In our annual Air Defense Number last August we gave you the outline of the project developed by the Army, Navy and Defense Commission long before it appeared even in the daily press. In Aviation for January, 1941, we were privileged to present the streamlined aircraft procurement program on the eve of its period of greatest acceleration. (See "The Truth About the Defense Program" by T. P. Wright) This brilliant study carried us up to the spring of 1942. But, as we intimated in these columns in April, there has been much new planning and there are new and greater programs in the making. Some of these projects are intended to utilize the expanded productive capacity that will be available in 1942, others are planned to increase that capacity still further, and to utilize it. In selecting the proper time in which to make an appraisal of progress and to look ahead, we are handicapped by inability to predict the ever changing needs of the Democracies, which give birth to larger and larger programs so that what we say today may be changed tomorrow. But the timing of this presentation is such that we believe that we may depend upon it for some little time ahead. And we will make every effort to keep you informed of changing developments in our regular issues.

» ANOTHER LESSON for us may be found in the use of gliders by the Nazis, who are attempting to use them in their invasion of Crete as this is written. It is too early to appraise the results of this new type of warfare. But in the light of this latest German attempt to utilize all types of aircraft, it may be well for us to re-examine the possible military uses of light planes and gliders. Perhaps the Annual Soaring Contest at Elmira this month will take on a new significance in national defense.

» WE ARE HAPPY TO REPORT that the aviation manufacturing industry is well ahead of schedule. In the first five months of 1941 we have produced as many military ships as we did all last year. All signs point to a three-fold increase in deliveries this year over last. By the end of this year we shall be turning out airplanes at the rate of 2500 per month or ten times the rate at the beginning of 1940. The present rate of acceleration is greater than that of either England or Germany at any time. We have reason to be proud of this performance.

» THE PRODUCTION PREDICTIONS in January by T. P. Wright have proved to be very close for the first three months, with April slightly ahead of the estimates. Now we are attempting to project predictions to the end of 1943. Although there may be some ups and downs, the curve on page 42 should come close to actual results.

» IN THE PAGES of this issue we have attempted to show the work of a large number of the defense manufacturers. Space limitations prevented us from reporting on some who are making highly important contributions. Particular mention should be made of the part now being played by the builders of primary trainers. In past issues we have told you something of their accomplishments. In future issues we hope to report more fully on them.

» EVEN THE MOST SKEPTICAL should be convinced by the record so far that we are progressing as rapidly as humanly possible and that the methods are sound. One of the worst things

that could happen to this [illegible] would be any political interference or any dabbling by Congressional committees that might interrupt or modify the program in any way.

» ONE HORRIBLE EXAMPLE of a Congressional committee slinging mud into the waters is all this talk about the stalling characteristics of the Douglas DC-3. It boils down to something like harping on the fact that all Pullman cars will go off the track if you run them around curves too fast. Most airplanes will stall if you come near enough to standing them on end. So you simply don't come near to standing them on end. If the Douglas transports had not been flown 2,061,236 hours or 299,232,980 miles up to May 7th of this year, if the DC-3 had not been the airplane everybody used to make the 17-month non-fatality record, if it hadn't been tested by the manufacturer, the airlines, the Army, the Navy, and a lot of other people in a lot of other countries, if it had a competitor who was anxious to put it out of the running; if the U. S. and foreign airlines, the Army, the Navy, and others could throw all their DC-3s away and replace them by any other ships, or even if the railroads didn't have all they could do for the defense program, we could see some reason for all this talk. But as it is, we can see no purpose at all in this phase of the present investigation. Anyway, the traffic figures show that the public hasn't swallowed all this useless prattle. We wish we had a couple of hundred DC-3s to sell right now.

The lines still seem to buy them when the government doesn't want them urgently and we were gratified to learn that quite a few were delivered to commercial operators last month. This seems to indicate that our defenders have come to the wise conclusion that the front line is nothing more or less than the assembly end of a great conveyor belt which must be fed rapidly and efficiently from many scattered places far behind the lines.

» BUTCHERS, BAKERS, stenographers, and secretaries are riding the airlines these days and limited income is no longer a handicap to those who wish to travel by air. This is now possible because of Travelers Credit Corporation, which provides installment purchase of airline tickets. We will know more about the effects on traffic of this valuable service after the close of the coming vacation season. It is unfortunate that this wasn't started before the airlines became so important to defense that paying passengers were being refused transportation to make space for important government officials on urgent defense missions.

» DEPUTY CHIEF INSPECTOR GEORGE M. SEARLE of the New York State Police, makes an excellent suggestion for pilots everywhere to cooperate with police authorities. His letter follows:

"I am wondering whether or not it would be practical for you to urge pilots who PX their way ahead to cancel these PXs or, in the event that something prevents them from reaching their original destination, to notify the place where they started from, or the place they intended going, regarding this change.

"It frequently happens that we receive reports of lost airplanes and after spending considerable time and effort in locating them, discover that the pilot has changed his mind and gone to another airport without mentioning it. This has the same effect as the old legend of the boy who cried 'wolf' for it may be that some day when a pilot is desperately in need of help, he may fail to get it because the police will have grown tired of spending their time and effort to discover that the pilot is safe at home in bed."

IT PAYS TO FLY

» ACKNOWLEDGMENTS. Besides the authors who have taken time out from pressing defense duties to contribute to this production issue, we are deeply indebted to many others who have cooperated with us in bringing this information before you. Included in this group are: Colonel Robert Candee, Major J. K. Gowen, Jr.; Captain Frank Miller, other officers of the Air Corps, and Colonel A. R. Ginsburgh of the War Department; Mrs. J. B. Hancock of the Navy Department; Messrs. T. P. Wright and Allen C. Rankin of the Office of Production Management; Messrs. Howard Mingos and Leon Schloss and many others.

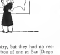
"Maguire is figuring out a way to meet that 5,000-plane a month program he heard about."

Side Slips

By Robert Osborn

» EVENTS certainly do move fast in this here aviation business nowadays, what with airplane, engine, propeller and accessories plants springing up like mushrooms all over the country Even officials of the various manufacturing companies seem to have difficulty keeping up with their divisions For instance, in the May *Reader's Digest* is an article entitled "First Line of Defense Against Strikes," condensed from *Current History and Forum* One sentence in this article states, "The settlement of the Vultee Aircraft strike in San Diego last winter is an example of the effectiveness with which the conciliators employ these resources"

Vultee officials knew they did have a number of plants in various places about the country, but they had no record or recollection of one in San Diego Of course all plants connected with the industry, once completed, are immediately enlarged two or three times the original size, so the Vultee management looked also in the book labeled "Plant Expansion" Still no record.



It is reported that they are considering the hiring of a private detective agency to locate this San Diego plant, as the additional space would come in handy right now

» THIS COLUMN is having a difficult time of it putting the poet Tennyson in his proper place. Recent attempts to halt the epidemic of his "magic sail" verse among after-dinner speakers brought about numerous letters to the Editor which must have caused "reasonable doubt" in his mind When it was pointed out that "Pilots of the purple twilight, dropping down with costly bales," did not even qualify Tennyson as a second-string prophet, most of the letter writers arrived at the conclusion we weren't fit to hold the reins while John "Information Please" Kieran mounted for another breaking of lances with the public on the radio What, they asked pointedly, about the lines following those quoted previously?

Heard the heavens fill with shouting,
and there rain'd a ghastly dew
Of the nation's airy navies
grappling in the central blue"

All right! Just to keep the Circulation Manager out of this office for a while we'll classify Tennyson as a prophet However, he can't play on our team as we're much more in need of a fast short stop and two outfielders who can hit

» INCIDENTALLY, while we have this fellow Tennyson in our hair we'd like to ask if anyone ever carried a "costly bale" in aircraft of any kind? We've heard of everything from electric stoves to alligators being carried in airplanes but never a single costly bale

And don't come back at us with any talk about poetic license either Being in the airplane business where one is either right or wrong we demand facts on the barrel head

Furthermore we suggest that some of these speakers and subscribers read Dr Samuel Johnson's *"Rasselas, Prince of Abyssinia,"* copyrighted in 1886

There was a lad who really got down to details while doing his prophesying

So far as this column is concerned, Dr Johnson is the All-Time All-American Prophet

» WE HEAR TELL that some of these new aircraft factories are being built without any windows or sky-lights, being artificially lighted and having ventilation with controlled temperature and humidity

Whoever thought of that certainly had an eye to the future Comes the end of the war these factories will be useful for growing mushrooms, during the period the industry is engaged in beating its swords into putt-putt puddle jumpers

» FOR THE GOOD OF THE INDUSTRY we hope that these windowless factories have at least a section of the office building, *with* windows, for the Engineering Design Department From our observations all good designers have to do a lot of looking out the window before they can tell a draftsman where to start the centerlines for a new design,

PRODUCTION FOR AIR DEFENSE

In the National Defense issue of *Aviation*, published last August as the first of the expansion assignments were being issued, the theme of aircraft manufacturers was "We are ready!" In the few months that have passed since then the U.S. aviation industry has wrought a miracle. The theme of this issue, devoted to aircraft production, might be "The ships are rolling out—we are ahead of schedule." The following pages tell the story.

By Maj. Gen. H. H. Arnold

Chief of the Army Air Corps and Deputy Chief of Staff U S Army

During a period of financial starvation extending over a period of several years, we all thought in terms of one- or at the most, ten-airplanes at a time Today we are thinking of airplanes in terms of thousands One of our hardest jobs is to synchronize our training of pilots, navigators, and mechanics with the production of planes and the construction of bases so as to have them all come out even at a predetermined time, to form a fighting unit That balance of production, training, and construction is a difficult task but it is not impossible, with the hearty help of the American aviation industry

By Robert P. Patterson

Under Secretary of War

The United States is now on the way toward its all important goal of air supremacy Day by day we are growing stronger in the air, and every day we are helping democratic Britain attain greater strength aloft.

I am most happy that I can make such a report on progress today happy, too, that I can make it on the occasion of this aircraft production number of AVIATION, for this magazine, like the industry it depicts, is fullheartedly devoted to America's greatest need—adequate national defense at sea on land and overhead

By Frank Knox

Secretary of the Navy

The recent decision to increase manufacturing facilities for speeding up production of bombers is significant of the important role aviation is playing in offensive warfare The result of the battle of the Atlantic hinges on gaining control of the air as much as it does on the defeat of submarines and surface vessels blocking the ocean lanes The Axis powers have been particularly adroit in coordinating their forces on, over and under the sea Aircraft have been used effectively in the war of the water in much the same manner as they have become the new artillery in the advance of land forces.

The ingenuity of American business is stepping up our plane production to the point where the numbers of our planes will darken the sky before many more months have past. This will enable the Navy to patrol every mile of our long coast lines and far out to sea, adding to the bastion of hemisphere defense Any major engagement of combatant sea forces would be preceded by a fight for air control Without it a modern fleet would be hampered in its aim to hit first and hardest

By Merrill C. Meigs

Chief of Aircraft Section
Office of Production Management

It is with a great deal of pleasure that I avail myself of the invitation to participate in this number of AVIATION devoted to National Defense.

The achievements of the airplane industry during the year just passed are sometimes taken as a matter of course in this desperate drive to obtain the tremendous goals necessary to perfect the defense of this country, but I can assure the people of the country that in no crisis has a group of men ever accomplished what both management and labor have performed

The stiffest job is, and has been, defense aircraft production A new technic had to be devised new factories built and new men trained This I say, without reservation, is being done.

Today American airplane builders together with the air services of the Army and Navy have placed in the hands of the fighting services the best planes in the world

I believe the American aviation industry has performed a miracle, but one miracle is not enough We need a daily miracle and that is the goal

By Col. John H. Jouett

President,
Aeronautical Chamber of Commerce

Last year the aviation manufacturing industry exceeded its own best estimates by producing 5,800 warplanes. Today there are approximately 44,000 planes on order It is doubtful whether any industry ever confronted so daring a challenge. We feel confident that we will produce 18,000 planes this year—30,000 in 1942 Meanwhile, additional requirements under consideration by our Government and other sources may raise the total number of planes on order to 80,000

There are still a few people who say "It's impossible!" They cite statistics to prove that it can't be done But the aircraft manufacturers are too busy to argue—they are doing it the job that must be done

From 5,800 planes to 18,000 planes, to 30,000 planes—and then what? To date the industry is meeting the production schedules imposed on it. It is solving the countless problems incidental to such an enormous industrial expansion

Construction of new plant facilities from just over 17 million square feet of floor space last July, 1, to more than 31 million square feet in March, 1941, and still the building goes on

Recruiting and training of new workers on July 1 1940 the industry employed about 120,000 workers Eight

(Turn to page 176)

Air Power in the Making

Military aircraft procurement has made tremendous strides since last fall. Production is now well ahead of schedule.

By George H. Brett, *Major General, U. S. Army, The Assistant to the Chief of Air Corps*

THE story of procurement of aircraft for our air force is inseparable from the inspiring saga of the tripling of production of our aviation manufacturing industry in less than a year.

While the exact numbers and composition of various types of aircraft in our air force must properly remain a military secret, the following figures can well be a source of pride and satisfaction to every one of our citizens, and particularly to all those loyal workers who have contributed unstintingly to this record achievement in an industry so vital to our national security—perhaps to our very existence as a nation.

In April the industry produced 1,427 military aircraft of all types, plus 78 large commercial airline ships. This is very near the goal set a year ago for a production rate of 1,500 military aircraft a month by July of this year. In the first six months of this year the industry will have exceeded the total production for the whole of last year, which was approximately 6,000 planes, and the industry may not get into high gear until fall.

In addition, contracts have been let for all of the 18,000 planes provided for by Congress, and four government assembly plants have been established by the War Department to produce additional bombers under management contracts with existing manufacturers. Over and above this tremendous total, the President early in May announced that orders for big long-range bombers would be increased to the very limit of our capacities.

In other words, an industry which last year produced 6,000 planes with a dollar volume of a little over half a billion, is now building for the Army, Navy and the British, including Canada, about 44,000 military airplanes. And all indications are that additional requirements under consideration by all these sources will raise the total by tens of thousands more. It is no less than a modern miracle!

Major Gen. Brett

Accelerating Production Capacity

How has this amazing expansion in production capacity been achieved? First, there was an interval of some months between the time of the President's message to Congress after the fall of France, when he said the United States should have 50,000 airplanes, and the time when the money was made available and work begun on contracts. Those manufacturers who were in a position to do so went ahead and built as many privately financed additions to their plants as they could.

And second, because of the large British and French orders, placed after Munich, the industry had already spent $52,000,000 for new plants and equipment by July, 1940.

But just see what has happened since that date. On July 1, 1940, the industry was utilizing 17,216,410 square feet of floor space. Eight months later, by March 1, floor space had been expanded to 31,383,967 square feet, an increase of 82 percent. During the same interval, employees of the industry increased from 120,106 to 226,172, an 88 percent increase. Virtually all of the new employees had to be trained within the industry.

This latter expansion was made possible through passage of the Emergency Plant Facilities Act, which made it possible for contractors to the government to expand their facilities and amortize the cost in several ways. One plan calls for the construction of new plants by the Army. The plants are then leased to the contractors. Or the contractor can build and finance the plant expansion himself. In that case, the contractor is reimbursed by the government in 60 equal monthly payments. Another plan calls for the contractor to build and finance the plant expansion, then amortize the cost over a period of 60 months from gross income. This saves the normal and excess profits taxes from this portion of his income. Under a fourth plan the government builds the plant, and finances it through an RFC loan to the Defense Plant Corporation. The government in this case retains title to the plant and leases it to the contractor.

Expansion of the aircraft engine industry presented an even more difficult problem. Only three manufacturers were available to supply engines in the higher horsepower classifications required for combat types. But the engine manufacturers met the challenge. They made considerable additions to their own plants, and subcontracted as much of their work as possible with firms in the automotive industry. They also made a close study of automotive engine production and adopted some of the latter's mass production methods, with the result that their output has been stepped up appreciably.

Propeller and accessory manufacturers have been handicapped by virtue of the fact that they are never fully aware of the requirements of a plane manufacturer until after the design and production of a new project is under way. However, a standardization project was conducted to remedy this drawback and its benefits are already being realized in a smoother flow of accessories to airplane manufacturers.

Air Corps P 39 Airacobras lined up at Selfridge Field.

Vultee BT 13 trainers at the factory ready for mass delivery.

Speeding Procurement and Deliveries

The Air Corps is now procuring airplanes, engines and equipment to an amount in excess of one and a half billion dollars, and another billion dollars has been requested for the production of the heavy and medium bombers in the Army's four plants. This does not include any funds or estimates for the augmented bomber production requested by President Roosevelt in his letter of May 5 addressed to Secretary of War Stimson.

The obligation of these funds presents a difficult task, for the volume of contracts has increased many times over and every step in the processes of procurement has been speeded up to the limit.

For example, auditing practice and methods of awarding contracts have been improved wherever possible to expedite orders. Originally the Air Corps had a small traveling audit force which annually audited all completed contracts with the principal manufacturers. With the advent of the expansion program and the complications incident to cost-plus and other new types of contracts, the auditing force was greatly expanded. Now there are resident auditors in the principal airplane, engine and accessory manufacturing plants in order that cost data can be currently compiled and the costs segregated between the several contracts. In this manner cost information can be supplied quickly to the contracting section for use in its negotiations for similar items, and the audit can be furnished with the least practicable delay after the completion of the contract.

The normal method used by the Air Corps in awarding contracts is by advertising for bids. A comprehensive mailing list of all manufacturers is maintained by companies and by articles. Invitations for bids are circulated to possible suppliers, and all bids are opened at a designated time. Award is then made to the lowest responsible bidder.

In case no one bidder is able to fulfill the delivery requirements of the expansion program, split award is made to the lowest responsible bidders. Contracts may also be negotiated when certain conditions of the proposed procurement make such action to the interests of the Government. An example of this method is the "sole-source" purchase.

In negotiating contracts, the proposal of the contractor is received and carefully analyzed. Consideration is given to all contributory factors, such as previous prices paid for like or similar articles, engineering estimates of cost of producing, study of the audit of costs of previously procured like or similar articles for comparison of each broken down item of cost, the interrelationship between items, and the percentage of each item to the entire cost, facilities available, and if none exist in industry, the qualifications of the proposed contractor to acquire necessary facilities; the position the proposed manufacturer holds in relation to the industry and other companies therein; the financial and management status of the proposed contractor, and his reputation and general ability to produce as desired.

Finally, after exhaustive analysis, investigation, and negotiation, an agreement is reached and is drafted, compliance with all applicable regulations and laws is insured, and the finished draft developed into a formal contract accepted and signed by the proposed contractor and the contracting officer.

Another example of the quickened tempo of procurement is provided in the present procedure for testing the finished product. The Air Corps used to service-test airplanes over a period of one year and then apply the results of this careful test to the final product.

But a year is too long in the present emergency. Kinks are worked out of a new design in a few short weeks of exhaustive tests by pilots working in relays. In this brief space the new designs are put through all the paces that a ship would undergo normally in a year. The first three planes off the production line are put through a grueling 150 hours of simulated combat testing with full military loads. Engine and accessory manufacturers stand by to make any alterations necessary in their equipment. In this way, any defects are quickly discovered and the manufacturers can be notified of advisable modifications before production has progressed too far.

Still another contribution to accelerated production is the encouragement of subcontracting. On the Army's big four-engine bomber, for instance, there are some 400 different items handled by subcontractors on the one airplane. There are still many industrial establishments holding no defense orders.

The bomber program is, of course, a long step forward. This program contemplates both four-engine type and two-engine types. The automobile companies will be the major suppliers of components for delivery to the four assembly plants. These factories are now under construction at Omaha, Nebraska, Kansas City, Kansas, Tulsa, Oklahoma; and Fort Worth, Texas.

Even while seeking maximum speed of production, however, utmost flexibility is maintained to insure our obtaining the latest possible designs. If one of the Axis powers should bring out a plane with revolutionary new features which would also improve our own product, the changes could be incorporated in our models. Procurement of an airplane is set up on a basis that would enable us to make certain modifications, we will say, on the one hundredth item. We will buy several hundred more, then make further improvements if desired. Thus, the last airplane delivered might be quite different from the way the original product was designed.

Materials and Labor

Some delays are natural and inevitable in a program of this magnitude. There was some over-optimism with regard to supplies of aluminum in the early stages of the program, but the situation is straightening itself out now.

There have been no delays incident to shortage of trained workers in the industry, and up to now strikes have not had any serious effect on production of aircraft for the Air Corps. The cost of aircraft, however, has gone up approximately 20 per cent within the past year. This has been due to increase in both material and labor costs.

Visibility Unlimited

As for the future of our air power, on the basis of the facts here presented, we can confidently report: "visibility unlimited."

In keeping with the growing stature of the Air Corps, the General Headquarters Air Force, which is the organization charged with the air combat operations in the defense of this country, has now become *four* air forces. For training and administra-

(Turn to page 176)

30,000 Pilots
100,000 Mechanics a Year

plus a lot more bombardiers, gunners and navigators will be trained by our Air Corps.

By Brig.-General Davenport Johnson

Assistant Chief of the Air Corps and
Chief of Training and Operations, U S Army Air Corps

IN April the War Department announced that the rate of training in the Air Corps would be stepped up from 12,000 to 30,000 pilots a year. The number of mechanics will be increased from 45,000 to 100,000, with corresponding increases for navigators, bombardiers, observers, gunners and others

By the end of June, 1941, the Air Corps will have approximately 10,000 officers, an increase of about 300 percent over a year ago when there were only 3,222 officers In the same period the enlisted personnel of the Air Corps will have increased from 45,914 to approximately 140,000 plus 12,000 Flying Cadets

Under the original schedule the 12,000-a-year rate will be reached on November 1 of this year, when the class of 2,091 cadets who began their 30 weeks of instruction in March will graduate. To achieve this rate the Air Corps was utilizing 28 civilian contract flying schools giving ten weeks of primary training Twenty more civil primary flying schools are now being added, bringing the total to 48

The Air Corps will more than double the number of flying schools under its own operation, with the following increases basic training schools, from 7 to 15, advanced single-engine training, from 3 to 7 schools, advanced two-engine training, from 8 to 14 schools, flexible gunnery schools, from 2 to 3

Some idea of the magnitude of the training job invoked by the expanded program can be gained from the Air Corps' estimates of the maximum number of students in the various categories who will be undergoing training at one time.

In the civil elementary schools there will be 9,730, in basic schools, 6,515, advanced, single-engine, 2,178, advanced, two-engine, 3,872, bombardiers, 1,610, navigators 2,110, gunners, 2,800

The time required for completion of the Flying Cadet course will remain 30 weeks ten weeks at a civil elementary school, ten weeks at an Army basic training school and ten weeks at one of the advanced flying schools

In addition to these pilots, the Air Corps needs from 800 to 1,000 men annually to commission as technical specialists in connection with engineering supply and procurement They are for the most part reserve officers and training corps graduates who have majored in aeronautical engineering and business administration They are on a non-flying status

Then there are a great many more non-pilot flying officers who are specially trained as bombardiers, navigators, A C engineers, communications specialists, observers, armament specialists, meteorologists and photographic specialists Requirements and length of training vary for these subjects but a considerable portion of the students selected are from Flying Cadets who, through no fault of their own, lack the extraordinary inherent flying ability required for graduation from the Army's stringent flight courses

Official photographs U. S. Army [illegible]

Mechanics work night and day to keep planes rolling

The layman is prone to think of air power in terms of so many airplanes, so many pilots and ground personnel But numbers alone mean nothing

To be effective, pilots must be not only fully trained, but prepared in proportionate numbers for particular missions Pilots of multi-engined long-range bombers must possess the accumulated experience of thousands of hours in the air plus special characteristics making for sound judgment and careful maneuvering of their expensive and destructive cargoes These pilots do not participate directly in gunnery and bombing, for example Crew members trained in those specialties man the cannon, machine guns and bomb sights

Not so with the fighter or dive-bomber pilot He is selected for his slight build, his rapid-fire coordination and his youthful dash He's pilot, navigator, flight engineer, gunner, bombardier and radioman all wrapped up in one flying suit. Between these extremes are several other kinds of pilots, each necessarily possessing a special combination of skills in the exact proportions which will insure the proper performance of the aircraft and equipment to which he is assigned.

Mechanics and Enlisted Technicians

To keep pace with this rapid augmentation of the ranks of pilots and specialists, a far greater increase in the number of mechanics and other enlisted technicians is necessary There are now three schools for technicians at Chanute, Scott and Lowry Fields Two more are planned, one at Biloxi, Miss, and the other at Wichita Falls, Texas The Air Corps also has 15 civil schools training enlisted technicians under contract.

At the end of June a year ago there were approximately 4,000 enlisted men undergoing training in Air Corps or civil schools. Now, eleven months later, there are well over 20,000 men under instruction and the volume is increasing month by month

The regular courses include those for airplane mechanics, aircraft armorers, aircraft machinists, aircraft metalworkers, aircraft welders, parachute riggers, Link Trainer instructors, photography, radio operators, radio mechanics, teletype maintenance, weather observers, and supply and technical clerks

Advanced courses include bombsight maintenance, carburetor, electrical, instrument and propeller specialists, advanced photography and weather forecasters

And in addition to this, some 3,000 enlisted men are being trained as administrative clerks at commercial business schools selected by local commanding officers, the training period running from 13 to 16 weeks

In connection with the training of enlisted technicians a recent order makes it possible for men who have completed the eighth grade to be enlisted provided they obtain a satisfactory rating in a special aptitude test and are otherwise qualified Formerly, a high school education or a journeyman's rating in a trade was required.

The training program described has been carefully coordinated with the anticipated airplane deliveries No serious problem is expected to develop in connection with the acquisition of sufficient training planes to carry through the augmented program

Air power without qualified manpower is an unknown quantity But air power plus *trained* manpower is a measurable factor of national security. We will soon be turning out Air Corps pilots at the rate of 30,000 a year. If the demand should be made for still more pilots, we will meet that challenge too, without relaxing the present high standards of training

Pilot training is being carried on in many parts of the country.

Pilots and Mechanics for the Navy

By Rear Admiral J. H. Towers, U. S. N.

Chief of the Bureau of Aeronautics

THE major problem which confronts naval aviation is the coordination of four principal elements which enter into the program of aviation expansion, namely, (1) the procurement of airplanes, engines and accessories, (2) the personnel training program, (3) the development of naval aviation shore facilities, and (4) the commissioning of new ships having complements of aircraft.

The objective has been to make the consummation of these elements meet in a common point, and continuous effort is directed to this end. Thus, each of these elements must be geared to the others in this four-fold program.

We feel that the training program, and all of its related features, should be accorded high priority insofar as expansion of naval aviation is concerned.

In the training of its pilots the Navy is considerably ahead of the schedule which was planned last year. By the end of June we will have 500 more pilots in training than we had originally anticipated. On January 1, 1940, we had 2,924 pilots. On January 1 of this year, the number of pilots on active duty had been increased to 3,629. By January 1, 1942 the number of pilots will have been increased to approximately 6,000. This last figure includes reserves who have been called to active duty. At that time there will be approximately 5,000 pilots in training.

We now have three large training stations for pilots, located at Pensacola and Jacksonville, Florida, and Corpus Christi, Texas. In addition, there is a naval air station at Miami, Florida, devoted to specialized training in aircraft carrier types of planes.

Pilot training has begun at the 16 naval reserve bases scattered throughout the country. Each of these has a capacity of about 100 pilots per month for the elimination training. Those successful are passed through to one of the three naval air stations mentioned. Plans are being discussed concerning the building of four additional naval reserve bases, and these 20 elimination training bases would be capable of accepting 2,000 candidates for pilot training per month, which is a grand total of 24,000 per year.

At Pensacola we are now accepting 300 new candidates per month. At Jacksonville, where training has been recently started, the number of flying cadets accepted in June will be 175, but beginning in July the number of new cadets will be 200 each month.

Corpus Christi began its pilot training in April, and the number of cadets has been increased each month. Fifty students were accepted in March and this number will be increased until by July, 1941, the total will reach 300 per month.

Of the 707 pilots who finished their training at Pensacola in 1940, 119 were regular officers of the Navy, 514 were flying cadets who had come in through the Naval Reserve, and 74 were enlisted men of the Navy.

The number of enlisted men who are now Navy pilots is approximately 20 percent of the total regular Navy pilot strength. Because of the need of the Navy for additional pilots, it is obvious that opportunities for enlisted men to qualify are relatively greater.

In the calendar year 1940 we had 2,460 applications for training as flying cadets. Thus far we have had no real difficulties in getting applications, but a tremendous effort has been made and must continue to be exerted. In some areas of the country we have had difficulty in filling our quotas, but in other areas we have been flooded with applications. The number of applications received, however, is a reflection of the patriotism which inspires them. When young men realize that the country is facing an emergency they are quick to seek opportunities to share in the national defense. I well remember the situation during the World War when the Navy was absolutely swamped with applications from men who wanted to enter naval aviation. Many of the applicants are rejected because they do not have the educational, the physical or mental qualifications that are being sought. Of those accepted for the elimination training at the naval reserve bases, approximately 80 percent are able to finish the ten-hour training course and are passed on to one of the three large naval training centers. In the past, about 70 percent of those entering Pensacola were able to complete the training. These days a fair proportion of those who are not qualified for flight positions are given an opportunity to accept other ground assignments in the Naval Aeronautic Organization. These men have valuable educational or experience backgrounds which qualifies them for commissions.

Originally the naval aviation training was of thirteen months' duration. We have now reduced the time to seven months. Upon successful completion of this course the flying cadet is commissioned as an ensign in the Naval Reserve and is ordered to duty with one of the Navy's aviation activities.

Based on an earlier 10,000-plane program, 15,000 pilots would have been needed. For the current 15,000-plane objective we will need about 17,000 pilots.

One of the problems at the present time is to find qualified instructors for pilot training. We have called in a number of reserve officers for this purpose, and we intend to call more when the emergency warrants. We expect to operate our pilot training program on a six-day-a-week, dawn-to-dusk basis. If we do not find sufficient reserve officers who can aid us with the training program, we may call on civilian instructors who have passed through the advanced instruction courses given by the Civil Aeronautics Administration.

Mechanics' Training

Although there is more publicity attached to the pilot training program than to the problem of obtaining enlisted men in numbers sufficient to repair and maintain our naval airplanes, the Bureau of Aeronautics is convinced that mechanics' training is of comparable importance. Lessons learned in the last war and from foreign countries involved in this war teach us that any air force has a great asset if it has a sufficient staff of well-trained mechanics who can service an airplane and get it back into the air promptly. Mechanics of the Royal Air Force played a significant role in keeping Britain's airplanes in the air during the battle of Dunkirk last year and are doing so in the daily air battles that are now going on.

Under the Bureau of Navigation, which is in charge of training in the Navy, four Navy aviation mechanics schools have been established at the following points: Jacksonville, Florida; Norfolk, Virginia; Pensacola, Florida; and San Diego, California. This month two additional schools are being opened, one at Alameda, California, and the other at Seattle, Washington. The school at Jacksonville is the largest, having a capacity of 3,000 students.

Four types of training are given at these schools: Aviation metalsmith, aviation machinist mate, aviation ordnanceman, and aviation radioman. Each of these courses continues for four months. The course for aviation metalsmith covers the properties of metals, heat-treating, cutting, forging and aircraft welding and brazing. The course also covers electroplating and certain basic geometry.

In the aviation machinist mate course, basic instruction in the practice and use of all power tools necessary to the work of aviation machinists is given. Mechanics in this course learn the operation, care and repair of all types of aircraft engines used by the Navy. This is a thorough and concentrated course, and when enlisted men complete it they are qualified for engine work.

The aviation ordnanceman first specializes in the assembly, disassembly, installation and care of all types of guns and machine guns used in naval aircraft. He must also know how to use gun cameras, the use and precautions in handling explosives, and he must understand the housing and release of torpedoes and bombs.

The aviation radioman course provides instruction in general aircraft radio training. This is very much of a specialized field these days, and radio men taking this course are given intensive training. The instruction covers machine gun operation as well.

Candidates for these four courses have all completed eight weeks at the recruit school where they are sent immediately after they enlist in the Navy. During this course they are given intelligence tests, and applicants for the additional aviation training must do well in these tests.

In former years it was not possible for an enlisted man to be sure that he would be assigned to duty in naval aviation. At present young men may enlist in the Naval Reserve for a four-year period, with assurance that if they pass the tests at the recruit school they will be accepted for naval aviation assignment. When they complete the four months' aviation training course they are promoted to third-class petty officers and as soon as qualified at sea they receive pay at the rate of $60 per month. The next step in line of promotion is to petty officer, second class, in the particular field of work in which they have been trained. This gives a base pay of $72 per month. In the aviation branch of first-class petty officer the pay is $84 per month. Chief petty officers receive a base pay of $99 per month. There is also an opportunity for certain of these men to secure pilot training. As mentioned above, approximately 20 percent of all naval aviators are enlisted men. It should be borne in mind that an enlisted man ordered to duty involving actual flying in aircraft receives an additional 50 percent of his base pay.

Aviation work for civilians

It is not generally known that a large number of civilian mechanics are employed within the Naval Aeronautic Organization. They are hired for work at stations where naval airplanes are overhauled, such as Norfolk, Jacksonville, Pensacola, San Diego and other points. Civilians secure their positions through the U.S. Civil Service Commission. Details concerning qualifications can be obtained from the U.S. Civil

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WHAT NEXT
IN AIRCRAFT EXPANSION?

An Appraisal of Progress and a Glimpse into the Future

By Leslie E. Neville, *Editor, Aviation*

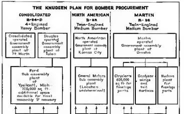
IN spite of puerile prattle of the uninformed, we have made progress beyond expectation in expanding productive capacity in the aviation industry. It is true that all of the pieces of the stupendous jigsaw puzzle have not been found, much less fitted into their proper places, but the spring of 1941 finds us well along the way and ahead of schedule. (See "The Truth about the Defense Program," by T. P. Wright, AVIATION, January 1941.) And the job is being done in the only possible way,—with the established aviation industry as the center from which all expansion must necessarily evolve. The military airplane delivery score for the year is: January, 1036, February, 972, March, 1216, and April, 1427. Total floor space as of March 1 was 31,383,967 sq. ft., total employees, 226,172.

The soothsayers and the miracle men have departed from our midst and have let us get down to work. The automotive industry has focused the spotlight of mass production technique upon the aircraft manufacturing job and has appraised it accurately as a job very different from its own. And it has rolled up its sleeves and gone to work to learn the new job from the bottom.

Anybody who thinks you can turn out airplanes just like automobiles hasn't seen an airplane. Consider the extreme case of a heavy bomber with nearly half a million rivets, or, if you think that is exceptional, take a medium bomber with its 30,000 parts (including rivets, nuts and bolts) which eventually find their way into 650 minor sub-assemblies, which become 32 major sub-assemblies which are put together to make the plane, all at a cost of some 30,000 man-hours of labor. Each of the two engines in this ship must have 50,000 separate inspections. Each of more than 50 instruments is a masterpiece of precision workmanship which would put the watchmaker's art to shame.

If you have columnist-inspired nightmares featuring fat, overfed aircraft manufacturers rolling in wealth shaken out of the banks of taxpayers' babies, take a look at these facts. Out of a representative group consisting of almost all of the defense manufacturers for the period 1934–1940 inclusive, as a sum of $63,250,000, or 79 percent of total profits went for development. This group also spent $76,800,000 (97 percent of total profit) for plant expansion and equipment. These two expenditures add up to $140,050,000, or 76 percent more than total profits. More than $52,000,000 has been spent on new plants and equipment since the outbreak of the war in Europe, and that is just the beginning. Yet it is estimated that only $11,000,000 worth of that so far constructed will be needed after the emergency.

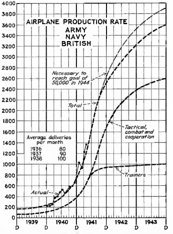
It would be dangerous for even the most astute financial crystal gazer to predict profits for aircraft manufacturers, and most of them have long since abandoned all thought of trying to foresee the figures. But no matter how you look at it, you can see from almost any angle that, as far as the aircraft industry is concerned, the government has been eminently successful in keeping profits out of war. The overall picture at the moment looks something like this. On the credit side, the Vinson-Trammel profit limitation legislation which singled out and hamstrung shipbuilding and aircraft manufacturing has been lifted, leaving the industry on the same basis as other defense industries as far as U. S. government business is concerned. Other things being equal, this should tend to improve the profit situation a little. But other things aren't equal and such factors as unwarranted expansion, accelerated delivery, and rising costs not covered in contract escalator clauses, conspire to place the manufacturer in an indeterminate position. On top of this, the Lease-Lend legislation throws almost all export business over into the category of U. S. government business and the excess profits tax robs the manufacturer of what once was his best source of reasonable profit,—the export market. So the plane maker's future is not likely to be a very happy one.



Expansion of the basic "Knudsen Plan" for bomber production (above) and the capacity of the parent companies and other aircraft plants will provide additional capacity for long-range bombers. In order to obtain this new capacity increment, Ford will build complete four-engined bombers as well as parts. Douglas, Lockheed and Boeing will increase capacity for these ships at their home plants, and new capacity is planned for Boeing at its Stearman Division at Wichita, Kansas

Now if you have any ideas about what should be done after the war with the $41,000,000 worth of strictly emergency expansion thus far built, and many times that much as yet unbuilt, please let us know. Aircraft manufacturers fall into two groups on this question. Group (1) is devoting every moment of thought and effort to the tremendous forced-draft expansion to prevent its becoming explosion. These fellows shy off the subject, some believing in a subconscious sort of way that they won't be alive to worry about it and it is a problem for the next generation of executives. Group (2) is indulging in flights of fancy about huge commercial demand for airplanes in a world full of airplanes and devoid of wealth after the war. It is extremely difficult for any man to grasp quickly the true proportions of this stupendous defense program. And it is easy to forget that if you increase anticipated demand for transport aircraft ten times, you still come out with a need only one-tenth the size of the present program.

Fortunately, however, there is a ray of hope and most of the plane makers have seen it and have seized upon it. It is research and more research. Manufacturers are building wind tunnels and laboratory facilities and swelling engineering staffs to work on projects far beyond immediate wartime needs, and the few who are not, should get busy and do likewise. For, out of the laboratory will come the aeronautical development or combination of developments that will be essential to the peacetime reconstruction of an impoverished and war-torn world. But scientific research is not enough. Studies must be made to find new non-aeronautical products to make in the over-expanded factories after the war.

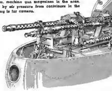


Recent increase in the proportion of long-range bombers in the aircraft production program have little effect on the numerical totals. They will have a more considerable effect on quantities of engines, propellers, and aluminum required since a long-range bomber uses double quantities of all of these. The above chart shows the overall proportions of the present program which calls for a capacity of 3600 planes and 9000 engines and propellers per month by the end of 1943. The dots show that actual performance through April has been very close to predictions and that we are ahead of schedule

But let's get back to 1941 and take a look at the programs which are growing every day and which are still growing as this is written. In spite of the 3-fold increase realistically expected this year over last, which means an 18,000 plane objective for 1941, this is only the beginning. Although Congress has appropriated funds for 18,000 planes, the industry is expected to produce 44,000 by the middle of 1942 and 80,000 by the middle of 1943. The present program calls for 16,500 for the Army, 8,500 for the Navy, 16,000 for British and Canada, and 3,600 bombers via the Knudsen Plan,—all sometime in 1942. While these are being built there is a concurrent capacity expansion and new programs are being developed to keep this capacity busy during the year following or to the end of 1943. These plans call for a capacity expansion from a rate of 2,500 planes per month, which should be reached by the end of 1942, to a rate of 3,600 per month by the end of 1943. But the latter figures will include a much higher percentage of combat planes over present production which is about 50 per cent. (See Figure 1). Whether or not these overall figures will be changed by the President's recent demand for 500 bombers per month will not affect the totals appreciably but will cause some rearrangement of the proportions of various types of aircraft details of which must be considered confidential now. This will of course increase the ratio of engines and propellers to airplanes because of the increased percentages of two and four engined types and the decreasing percentage of single-engined trainers which has been running at about 50 percent of total military production. It will also materially increase the tonnage of light alloys required (see the article Aluminum & Magnesium on page 70). The expected increase in ratio of engines and propellers to airplanes is from 2.2 to 2.57, which means approximately 220,000 engines and propellers for the 80,000 airplanes and a capacity objective of 9,000 engines and propellers per month by the end of 1943. And this, in turn, means a further increase of about 25 percent in capacity for these industries beyond all current expansion now underway. Rumor has it that another division of General Motors will be called upon to build high powered radial aircooled engines under license as Buick is about to do. The parent air-

(*Turn to page 172*)

Narrow doors on the side of the fuselage are used to service the four 7.3 mm. machine gun magazines in the nose. Guns are operated by air pressure from containers in the nose. Large opening is for camera.



NO ERSATZ

An American engineer looks at a German Messerschmitt

By Ernest Bruce *Chief Engineer, Vultee Aircraft, Inc.*

On Apr. 1, a Messerschmitt 110 fighter plane arrived in Los Angeles harbor aboard the freighter "Montanan," consigned to the Vultee aircraft factory from the British Air Ministry. Vultee engineers, and others as well, have now had an opportunity of making a preliminary examination of this interesting plane. This report is based on a more or less casual inspection of the plane as received at our plant. In attempting to present an examination of this famous fighter plane it is important to call the reader's attention to the fact that this type is actually now obsolescent, having first been flown in 1937, so that it does not necessarily represent the very latest practice in German design and construction.

An engineer's first impression of the Messerschmitt is that it is a thoroughly workmanlike machine, and this is borne out by close inspection. A surprising thing is how a crew of three men have been fitted into such a small airplane. In size and general arrangement the 110 compares closely with the Lockheed P-38. Span and weight are a little greater, as is the horsepower, while performance is somewhat lower. The Messerschmitt of this model is thought to have a top speed of about 365 m.p.h., which would be about 40 m.p.h. slower than the export version of the P-38. The crew of three men in the 110 are accommodated in tandem arrangement in a relatively narrow, but deep fuselage. The pilot is forward, of course, and has unusually good vision for a twin-engined plane. The rear gunner has a single pedestal-mounted machine gun, one of the plane's few obvious weak spots, while the radio operator is located in the center where he can also service the two belly-mounted cannon.

Perhaps it will help if we first dispose of the armor and armament question before considering the detailed design and construction of the plane. While the two fuel tanks and the oil tanks are of self-sealing construction, it came as something of a surprise to find that the 110 is not armored anywhere. What the plane lacks in armor, however, it makes up in forward armament. There are four 7.3 mm (approximately .30 caliber) machine guns mounted in the upper nose of the fuselage in fixed position. We would guess that these four guns, firing along the line of flight, might just about match the effectiveness of the British Spitfire eight-gun installation since the latter arrangement results in a fire dispersion which somewhat reduces effective range. But the real fire power of this plane lies in the two aircraft cannon, of 20 mm., mounted in the belly where the shock of firing can be transmitted directly to the heaviest part of the structure. Long steel blast tubes run forward a distance of about 5 ft. (from the gun muzzles) to the nose cowl opening. These two cannon, firing together, have proved most effective against targets both in the air and on the ground. In Poland these planes are said to have disabled railroad engines with fire from their cannon. And their effectiveness in aerial combat over England is indicated by the fact that the British are now mounting cannon on their fighters. It is not hard to picture the effect from a burst of fire at close range from all six forward guns of the 110, four machine guns and two cannon. But this forward power is gained by sacrificing rear protection, both in armor and armament. The single gun provided at the rear would be a poor match for any fighter which got in position for a burst. This rear gun is not well located or mounted, so that it covers a limited field of fire and seems to have been an afterthought. With the Messerschmitt's rear thus left so highly vulnerable it must be concluded that the designers of this machine relied on superior speed for protection. Against the British Spitfire this has doubtless proved to be a serious miscalculation.

Since no twin-engine plane is likely to stand up to a first-class single-engine pursuit in a dog fight, the Me 110 must be regarded as a hit and run weapon. It possesses deadly power for a single forward burst, but if that does not destroy the opponent it must then run for its life. Since the Me 110 is also used as an attack bomber it is fitted with external bomb racks under the fuselage and wings and particularly on short-range missions could carry an effective load of bombs.

Aerodynamically the Me 110 leaves little to be desired. Fuselage and nacelles are of highly efficient form. A remarkable feature is the manner in which size has been kept down without cramping accommodations or restricting accessibility. The twin-rudder tail is conventional. Exterior finish is extremely smooth all over, with flush riveting throughout. No projections are permitted to spoil the smooth surface of the machine and it is doubtless of a high order of efficiency. Both slots and flaps are provided, the flaps being of full trailing edge type, extending between fuselage and ailerons. Wings have a span of 55 ft., an area of 414 sq.ft., and aspect ratio of 7.3 to one. The taper ratio is not more than two to one. The wing tips are blunt and almost straight, but appear to be efficient, especially from the standpoint of stall control.

Completely disrupting the story about

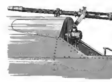
(Turn to page 142)

Comparative Figures

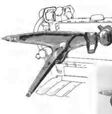
	(*Export version of P-38*) (Interceptor pursuit type.)	*Me 110* (Convoy Destroyer and light Attack Bomber)
Length	37 ft. 10 in	35 ft
Span	52 ft	55 ft.
Gross weight	13,080 lb.	14,800 lb.
Wing area	327 sq.ft	414 sq.ft.
Wing loading	40 lb./sq.ft.	35.7
Power	2,100 hp. (2 Allisons)	2,300 hp (2 Daimler-Benz)
Power loading	6.2 lb./hp.	6.4 lb./hp.
Speed	404 m.p.h.	365 m.p.h.
Range	600 mi	1,000 mi +
Service ceiling	30,000 ft. +	30,000 ft. +
Crew	One	Three
Armament	1 cannon 4 machine guns	2 cannon 5 machine guns

(An additional cannon is reported being fitted)

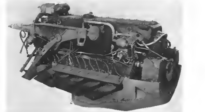
General view of the Messerschmitt Me 110 showing the easily detachable nose cowl for quick access to the guns.



One of the Me 110's weak points is the single rear machine gun with its ineffective mounting



The engine is supported on standard forged magnesium arms, with large rubber bushings at the support points. This mount gives easy access to the accessories on the engine and is easily removable for repair work.



The Daimler-Benz, 1150 h.p. engine is furnished with a simple spur gear giving right hand propeller rotation, as in this country. Propeller shaft is hollow which would permit cannon fire. Dual ignition is supplied by Bosch magneto shown at lower right. Cylinder blocks are attached to crank-case by internal attachments, probably a single large nut on threaded cylinder sleeve of each cylinder.

Curtiss Punch Press Department's orderly and efficient layout.

APPLYING MACHINES TO
Quantity Production

By P. N. Jansen,* *Factory Manager Curtiss Aeroplane Division Curtiss Wright Corporation*

DID you ever try to make one bolt with an automatic screw machine? We haven't either, and few people would doubt that such a procedure would be unwise if you had only one bolt to make But if you have 10,000 bolts to make, an automatic screw machine would be just the thing. Applying a similar philosophy to building an airplane, one or even ten might be "hand made" when compared to the way a thousand would be turned out But the problem of airplane production is a little more difficult to solve than are products that are more adaptable to the American idea of mass production

There are many reasons why a different interpretation of "mass production" must be applied to military aircraft. Important among these are the changes and improvements in design which this industry must make to keep in advance of improvements made by foreign countries. Another reason is that we do not have any one model which we can consider satisfactorily ahead of all others to depend on setting up a system of mass production to produce it.

Many people realize how foolish it would be to undertake our aircraft program with the idea of building every ship completely by hand But few stop to consider that it is almost equally foolish for the industry to undertake airplane construction solely by machines, because any program within the range of reality would still be of such a small quantity that an "automatic machine" could not be used.

The balance between these two methods resolves itself into a "best way" which is formulated through a careful evaluation of all the factors entering into production Some of these factors are: power cost to operating any number of pieces of equipment, tool cost, labor cost, remaining labor costs because of incomplete operations quantity to run at one time; set-up time, and material waste When these factors are considered for various quantities of airplanes, there is, for most of the parts, a definite point in which the quantity to be made justifies the use of more automatic equipment. (See charts, Figures 1, 3, 5, 7, 11.)

Some parts by their physical nature are impossible to build by any other than manual methods Others adapt themselves to using machine methods for a large quantity, and the accompanying charts are aimed at representing a few typical units showing at what point a new production system could be economically possible. When a similar study was made of the majority parts of a pursuit airplane the results indicated that a quantity of from 300 to 400 airplanes of exactly the same design should be ordered at one time to warrant the efficient use of quantity production methods

When first faced with the possibility of an increased production program back in 1938, the Curtiss Aeroplane Division began looking for ways in which to obtain the maximum number of "best" ways. Having progressed from the old stick and wire days to all metal construction there was a great deal more technical knowledge required in the selection of equipment. And it was with an eye towards building a large number of relatively similar parts that moved our production methods into a category which utilized more and more machinery. This use of machinery did not replace workmen, but instead gave them a tool to work with which increased their productivity As a result the quantity of parts turned out enabled Curtiss to reach the record of ten P-40 pursuit planes a day without any great increase in personnel or factory space.

Since the true meaning of the term mass production has become somewhat obscured, it will be helpful before proceeding further to stress the principles of mass production The general belief is that mass production involves only the manufacture of a large number of identical parts, usually by means of special machine tools Quantity alone does not make mass production Therefore, it is necessary to distinguish between large quantity and mass production, as it is sometimes possible to apply basic mass production technique to even a limited quantity

Before enlarging upon the subject matter, it is necessary to observe basic premises in regard to manufacturing

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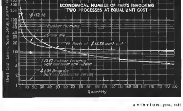
Fig. 1 Comparison of two methods of making an engine cowl (see Fig 2.)



PROCESS No. 1 (DRAW DIE)

L = UNIT COST --- LABOR AND BURDEN $1.39

T = TOOLS AND SET-UP COST $585.00

PROCESS No. 2 (RUBBER FORMING)

L_1 = UNIT COST --- LABOR AND BURDEN $10.42

T_1 = TOOLS AND SET-UP COST $142.50

N = ECONOMICAL NUMBER OF PARTS AT EQUAL UNIT COST - LABOR, BURDEN, TOOLS AND SET-UP

(1) $\frac{T}{N} + L = \frac{T_1}{N} + L_1$

(2) $\frac{585}{N} + 1.39 = \frac{142.50}{N} + 10.42$

(3) $585 + 1.39N = 142.50 + 10.42N$ (MULTIPLY BY N)

(4) $585 = 142.50 + 9.03N$ (SUBTRACT 1.39N)

(5) $9.03N = 442.50$

(6) $N = \frac{442.50}{9.03}$

(7) N = 49 PARTS

Fig 2. Formula by which costs in Fig. 1 were computed.

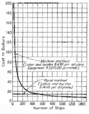


Fig. 3. Point where improved equipment can be used in the drilling and countersinking rivet holes in stringers

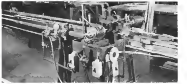


Fig 4 Machine that has been developed at the Curtiss plant for drilling and counter sinking rivet holes in stringers mentioned in Fig. 3.

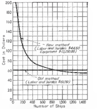


Fig 5. Determining size of contracts for which it would be economical to get improved tools to use in machining landing gear cylinders.

Fig. 6. The Baker Drill, for drilling out solid piston forgings, is also used for landing gear cylinders.

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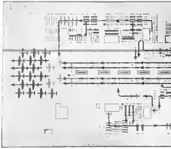
* In gathering this material Mr. Jansen collaborated with George Ebam, Production Control Supervisor and William Dreckend, Chief Tool Designer

By
Omer L. Woodson
Vice President,
Bell Aircraft Corp



The new Bell assembly plant has four assembly lines.

Assembly Line Control

With the Airacobra comes a new philosophy in airplane production

A SUCCESSFUL production line is built on the hours of planning and preparation that go into its efficient organization. Without having the correct materials at the correct place at the correct time there is bound to be a delay, and a delay often means not only a loss of time and money at that point, but perhaps even a greater loss at some point further down the assembly line. In working out the production system for the Airacobra, the primary idea held foremost in the minds of the production engineers was to keep a constant flow of parts to each point in the assembly line. Back of these points were built all of the various systems and subassembly lines originating when the raw material was delivered to the plant

Basically the final assembly line consists of 15 individual stations extending in a line down the length of the plant. In setting up this line a careful study was made of the complete assembly of the Airacobra according to the time necessary for each succeeding step Once this study was completed the assembly operations were grouped so that each of the 15 stations were allotted assembly operations that could be accomplished in 8 hr.

At each of the 15 stations is located a storage rack in which are stored the materials To keep a running record of the materials on hand so that at no time will there be a shortage, a simple checking system on charts was devised The operation of this was planned to consume a minimum of time and paper work At each station is posted a material control chart on which are listed all parts necessary for assembly at that station Made out to the right of this listing are squares according to the number of airplanes for which there are available parts. When material has been brought by the finished stock clerk he places the correct marking on the chart The leadman at the station then checks this and on finding it correct places his mark, then when the part has been assembled on the airplane, this is also noted If the dispatcher at the station does not approve of the stock and has it either scrapped or sent back for reworking, he enters his mark so indicating, thus erasing all of the other markings With this an accurate accounting is kept at all times of exactly how many parts for Airacobras have been stored at that station, with parts kept in supply for ten ships ahead If there are any parts lacking this can be quickly seen and new ones brought, and as these control charts are mounted in a very visible place it takes only a few minutes to check on the condition of the complete assembly line However, with the subassembly feeding right into the main assembly there are no finished stores because the number of parts produced are controlled from the beginning of the lines through the work order priority system

The beginning of the fuselage subassembly line in the main Bell plant. The two main beams are shown in the foreground moving down to where the skin is attached and then to the right feeding on to the assembly line. These beams mount the engine at one end and the propeller at the other, the tail being added later.

Planning Behind the Line

However simply the assembly line is set up for operating, there still is the big factor of feeding the material to this line The process of doing this has been, as in other companies, left in the hands of the production division Their work begins as soon as the design of the airplane has progressed to a point where it seems feasible to produce it. They consult with engineering during the design stages to make sure

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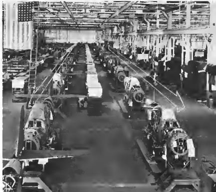
A cockpit cabin is made in its own sub-assembly line leading from the right to the left then forward on to the main line

Wing construction starts at the left of this line moves on down, the finished panels being stored at the right. From here they move across the plant to the assembly line where they are attached.

Looking back along the assembly line. The fifteen stations can be seen extending to the back; each one having its own supply rack. Sub-assembly lines feed in from the left.



The P-38 is the only twin-engine interceptor pursuit now in production. Its design, speed and fire-power have attracted great attention.

BUILDING A

Bolt of Lightning

The British have named the P-38 the "Lightning". Both U. S. and England are counting heavily on this interceptor pursuit.

By R. A. Von Hake, *Vice President in Charge of Manufacturing, Lockheed Aircraft Corporation*

THE job of building the Lockheed P-38 Interceptor, which we believe to be one of the fastest airplanes in the world today, and which the British have named the "Lightning", is hard, solid work—and requires a lot of figuring, ingenuity, training of men for special highly skilled tasks, and experimentation, before we are able to do it on a mass production basis. Happily, we are now approaching that stage, and the "Lightning" is beginning to roll.

The assembly line in the main Lockheed factory, in Burbank, California, is 820 feet long. From the mating jig to the far-off door, where the P-38 pokes its nose for the first time outside, there will be 30 separate stations holding as many separate airplanes in various stages of development. In another plant, less than a mile away, we have an assembly line for the British version of the speedy fighter, and here also we plan to have 30 stations between mating jig and the completed airplane.

It was in this latter plant that we built the first three airplanes to follow the prototype, or XP-38, which Captain Benjamin S. Kelsey of the U. S. Army Air Corps flew from Riverside, California, to Long Island, in 7 hours, 45 minutes, 36 seconds, in February, 1939. And it was there that we encountered and solved the early problems, and there were many, which confronted the manufacturing departments, following the engineering and wind tunnel experimentation and research on this remarkable airplane.

R. A. Von Hake

The P-38 is radically different in many respects from any other airplane of which we know, and certainly from any other airplane we have ever attempted at Lockheed. The extremely high performance for which we were striving made it of paramount importance to develop the airplane with the highest degree of compactness of which we were capable. The compactness in turn exacted precision development on a much higher order than we had experienced previously.

The fact that the airplane is the first twin-engined interceptor pursuit built in the Americas naturally presented problems of installation identical to the 21-passenger transport, complicated by the fact that the entire passenger list is a crew of one. The P-38, therefore, has the equivalent in instruments, controls, radio, etc., of a 21-passenger transport, and has armament problems in addition.

This compactness made precision of high order an absolute necessity, created the need for highly skilled tooling as well as for an extensive breakdown of components and sections of the structure in order that the work might be spread out, and large numbers of men employed with a minimum of interference with each other. These various broken down components in turn had to be joined to each other in a ready fashion, which required additional tooling.

In the development of this airplane (as is true with most of our developments) there was a great deal of preliminary structural research, and after and during the development there was highly developed shop and engineering liaison activity. The weight studies and weight control accomplished in this development were by far the best accomplishment in our experience. Our engineers worked constantly with special personnel.

On the tooling program, studies were made of the jig time, meaning the numbers of hours required in a jig for complete assembly. These studies formed the basis for the number of jigs of various descriptions that would be required for any given rate of production per day. In regard to the tooling, the interchangeability of major components was a highly important factor. We believe that in this development we have achieved the highest degree of perfection ever attained in aircraft manufacture in this country. The approach to our tooling program was largely responsible for this in that before any jigs were built, masters were constructed from which all jigs were fabricated and assembled. These masters have resulted in a high degree of standardization of the British and U. S. Army versions of the Interceptor. The thorough and extensive tool design in conjunction with the extensive development of masters is conducive to rapid duplication of fabrication of tooling for additional factories in different locations, if required.

The performance in top speed which we required necessitated flush riveting, a new technique which had been employed in our operations to a very limited extent before the building of the Interceptor. A long period of co-operative effort between the design engineering group, the tool engineering group, and the equipment shops resulted in flush riveting of which we are very proud. Men, however, had to be trained in this new technique.

After our experimentation with the tools, and the final determination of the methods and equipment, we established a school equipped to train classes of 75 men, with two shifts. The men were selected from the various assembly departments to receive this training, which covered a period of several weeks per class. The men were then returned to their production departments to train other men on the job.

There are now two types of flush riveting training—training off the job, and training on the job. The training before the man is placed on the actual production line is as extensive as possible. The training program off the job is in special classes conducted by Lockheed and local vocational and educational groups. This training period depends on the adaptability of a man's mechanical aptitude and usually ranges from one to three weeks. During this time he is taught assembly or framing, drilling, counter-sinking of various types, and, finally, the actual riveting. The standardization of flush riveting in our product allows all branches of education to specialize in this one type, the result of which allows the schools to give a greater output of students.

Simulating conditions to those existing in production is not entirely satisfactory, however, therefore final training on the job is conducted by the lead men under constant supervision.

We now have more than 5,000 trained men working on P-38 production, a figure which represents a notable advance over the few hand-picked men who were tailor-making the first YP-38 one year ago. The experimental development of this airplane was conducted by this small but steadily growing group at the plant away from the main factory because of the confidential nature of the project, and because of space problems which existed at that particular time, since which we have added more than 1,000,000 ft. of working space. It was thought that a concentrated, specialized effort on the single problem of the Interceptor development, away from production distractions, would be advantageous.

The pressure of subsequent defense orders necessitated further expansion of that plant as well as of our main factory, and it has now developed into a full-fledged assembly plant which we believe capable of producing as many Interceptors per day in line assembly as we can turn out in Plant 1.

Building of P-38's goes on day and night. Construction of this airplane is now a "first" on Lockheed's program.

Fabrication of parts for both the British and U. S. Army versions has been and will continue to be accomplished at the main plant. There the increased volume of orders has necessitated a rearrangement of fabrication and assembly floor space, and the addition of several million dollars worth of buildings and equipment has been made. The completion of these arrangements will result in a straight-line flow for sequence of operation from the raw material through the fabrication process, thence through processing and resistance treatment, to the assembly of various components, and on into and through the final assembly operations.

The fabricated parts are delivered to the component assembly sections at the beginning of the 820-ft. line. The main center section spar is the first assembly in this line. This main beam progresses to the next station where it is assembled to ribs and various other details into a center wing section. This in turn, upon completion, progresses to a station where the forward booms and the fuselage are attached. Parallel with the main boom and center section assembly operations are the assembly operations of the forward booms and the fuselage, the assembly of these components terminating at the mating sections.

The breakdown of assembly, as provided by Engineering, allows us to install the functional parts of the airplane in the early stages of assembly. As an example, the entire cooling system (Prestone), or Coolant cooling system, may be installed in the aft booms, or outriggers, at the time they are assembled in their respective jigs and work stations.

The forward gas tank installation is attached at the center section mating station, and this completes the unit that is commonly called the center section of an airplane. The part normally called the fuselage, which in the P-38 is merely the cockpit and armament nacelle, is built in two vertical halves, facilitating structural assembly as well as the installation of functional parts such as controls, plumbing and electrical equipment. The fuselage halves are, in turn, mated in the same manner as the center section, preparatory to the installation of all equipment from the armament section to the instrument board, inclusive.

The next assembly, which is peculiar to this type of airplane, is known as the body assembly, or body mating operation. At this point, the mated center section and the completed fuselage are attached, and the assembly known as forward booms are coordinated and attached to the center section.

The forward boom and center section together carry the landing gear and power plant installation. After removal

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Martin production engineers have reduced assembly operations to the simplest possible terms. Subdivisions of the bomber as shown on the opposite page are fabricated in units and brought together for assembly. These three photographs of a leading edge of a wing are typical of work simplification. Nose ribs are clamped in a vertical jig, each against a steel tongue. Then stressed skin, which has been set to absolute dimensions and stretched to shape in another department, is fitted over the ribs. Over the whole is lowered a steel drill pattern. The driller, shown in the center picture needs only to drill through the drill guides. Drill holes of different sizes have circles of different colored paint around them, so the driller knows immediately what size drill to use. When holes are drilled, the jig is hoisted, the sheet is clamped temporarily to the ribs and the whole unit is moved to the revolving jig shown at upper right. Here the riveters go to work. The convenient jig speeds up the work.

SIMPLIFIED Production Processes

Here is how the Glenn L. Martin Company has been preparing for the scarcity of highly-trained mechanics

IT was only a few months ago that Glenn L. Martin's employment office was demanding men of excellent backgrounds of vocational or practical training. Today, strange as it may seem, green men are walking into the Martin plant and taking up work on sub-assemblies that must be accurate to within a few thousandths of an inch. They are working with precision methods and precision tools new to the aircraft industry.

An interesting development, to be sure, but not so very remarkable. It had to come—either slowly in peacetime or suddenly under the stressful demands of wartime, whenever the demand for airplanes in large quantities should be made. The noteworthy aspect is that it came so soon after the American aircraft plants went on a war basis of production, with large orders suddenly dumped in their laps. How that came about—how the Martin Company came to develop its simplified processes—will be taken up presently.

The immediate consideration is that the whole industry faces the necessity of using men of hardly more than mechanical aptitudes. Each plant is scraping the bottom of the barrel of highly-trained mechanics, and the vocational schools and trade schools, for all their increased tempo, cannot meet the immediate needs of expansion.

It used to take three times as long to produce a fair aircraft mechanic as it did to get the first production model of a new bomber. But that belongs to the days when 20 airplanes were not an insignificant order—when the allotment for tools for such an order was necessarily small, and skill and judgment and the capacity for close measurements were absolutely essential. Then came the larger contracts when France, suddenly finding herself teetering on the brink of war, reached all too late for the helping hand of the American aircraft industry. Better tooling, more elaborate processes were hastily devised.

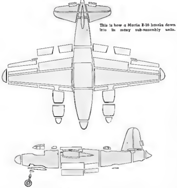
But today, with three billions of dollars in orders on its books, with 175,000 men on its rolls where a year ago it had a paltry 65,000, and faced with the necessity of raising the total to 350,000 in the next year, the airplane industry can no longer fit the man to the job, it must fit the job to the man.

That The Glenn L. Martin Company got off to an exceptionally early start in simplifying its machines, tools and methods is a matter, it appears, of foresight. About the time England and France and Germany were reaching for their guns, Martin was awarded, after competition, a $16,000,000 contract for B-26 medium bombers. Normally, the tooling outlay for such a contract would follow the old rule of percentages, but the situation was not normal. The United States, it was reasoned, would be forced into quick rearmament, the Allies would need every airplane they could get their hands on. The industry must expand rapidly, skilled manpower would be at a premium. Production rates would have to be stepped up by more modern methods.

So it was that Martin tooled elaborately, developed simplified processes for less-skilled hands. The B-26, designed as an ideal quantity-production airplane, was to be a production ship from the start—a ship without a prototype, cutting from six to ten months off the production schedule.

What, then, are these methods as manifested today in turning out one of the most formidable airplanes in the world? They are too numerous to detail fully, but a few examples will suffice as typical.

But first, it should be borne in mind that this airplane has more than 20,000



This is how a Martin B-26 breaks down into its many sub-assembly units.

parts, exclusive of standard parts. These merge first into 650 minor sub-assemblies, which in turn come together to form 32 major sub-assemblies and these meet on final assembly to make the complete airframe.

To achieve such a routine there was to be no cutting and trimming of parts into a fit. That would require high skill. Each component had to be made so accurately that it would fit exactly into its place in the assembly fixtures. Therefore, the basis of the tooling was heavy steel, so arranged into jigs and fixtures that each part in each sub-assembly would have its place into which it would fit exactly, with little opportunity for error.

Frames, for example, for the round monocoque fuselage of the bomber are assembled on big vertical wheels near whose perimeter is the steel guide into which the sections fit. Routed to the fixture in segments formed in giant hydraulic presses, or crank presses, each piece is clamped into its appointed place, and when all have been put in place, workmen drill through holes in a drill pattern, unable to make a mistake, as they turn the wheel slowly so that they may work at the level most comfortable for them. On another wheel, riveters complete the job of assembly.

Upstairs, in huge steel major-assembly fixtures, these completed frames can fit only in the guides made for them, for the frames are of different sizes, like a series of hoops over which the stressed and precisely stretch-formed skin is fitted to achieve the sweeping, streamlined contours of the B-26. This exact fitting of skin results from the stretch-press, introduced by Martin, which grasps the edges of the sheet metal and forces a die against it, stretching the metal into form.

There is an interesting use of colors in this tooling, particularly where a workman is required to stop what he is doing and do something else. The change of colors indicates the change of function. This supplementing the precise fit of the pieces, allows a semi-skilled worker to move surely and without mistakes.

Take the making of wing-spars as an example. On long, narrow steel tables there is a steel skeleton, just the shape of the spar. Now a wing spar, as most aeronautical people know, is made up of two heavy extrusions held together by a web of sheet duralumin which, in turn, is strengthened by angled cross-pieces

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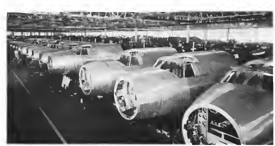


These B-26 nose sections will meet center sections at the final assembly stage

Getting the Most from Auxiliary Plants

Remote control enables North American Aviation to utilize fully its far flung production units

By Ronald L. Burla

Assistant to the President, North American Aviation, Inc

FIRST let us define what we mean by "shadow" plants North American has placed in operation the first of the aircraft factory branch plants to go into production under the expanded national defense aircraft production effort, at Dallas, Texas A second branch plant is under construction at Kansas City But these are not shadow plants in the sense that many people have interpreted the term A better word would be "reflection", for each of these plants is a clear reflection, or image, of the parent plant at Inglewood, Calif Each is an independent producing unit, controlled from the home office

Too many people interpret the term "shadow" plant to mean a plant which subcontracts some special part or group of parts and feeds such production in to a central assembly plant Something of this sort will actually be done under the bomber scheme with the automobile plants acting as shadow factories for the aircraft assembly works

But at Dallas we have developed a plant which stands on its own feet as a complete assembly unit, with the usual suppliers and subcontractors, of course Thus, and the factory at Kansas City may have their shadow plants — their subcontractors who will supply parts and assemblies — but each of the three North American plants will control its own production program

Ronald L Burla

However, the scheme under which these branch plants are set up and operated under a single master management is of special interest and significance in such a time as the present. Basically the process is as simple as the law of life under which the single cells of the body divide and multiply We simply divided our executive group and sent a part of them to Dallas from Inglewood to get the new plant going there The same process is being followed at Kansas City In doing this it is necessary to make promotions from the ranks at our home plant in Inglewood. It gives real opportunities for advancement to those men who have learned their jobs well At the new plants the organizations are built up around the skeleton force of experienced men under whom operations start. For example, at Dallas we started with 93 key men. Those men hired and trained their assistants and workers all down the line The result is that Dallas is already in full production, while the wheels of production have never been slowed for a moment back at Inglewood.

In addition to obtaining men for the new plants there has been the problem of engineering and tooling The new plants have been set up strictly as production units All design engineering and a major part of production engineering continues to be done at the parent plant in Inglewood Working drawings, charts, specifications, bills of materials, etc, are forwarded from Inglewood, to Dallas or Kansas City. Also the tooling, jigs and fixtures are mostly worked out in Inglewood and forwarded to the branch plants

From an executive standpoint we have found it desirable to establish a master organization chart with the various functions divided and assigned to key men Each of these key men has under his control an assistant in each of the three plants who is fully responsible for his own particular function The key man does not spend all his time in Inglewood, but actually moves from plant to plant, getting a birds-eye view of conditions and advising with his immediate subordinate in each plant This form of organization is clearly illustrated by the accompanying chart It will be observed that there are six department heads who answer directly to J H Kindelberger, president and managing director An executive staff helps to coordinate and expedite the work of the top executives under this scheme The six executive subdivisions are engineering, industrial relations, manufacturing, financial, quality control, and public relations For example under R H Rice chief engineer, we have an assistant chief engineer at Inglewood, one at Dallas, and one at Kansas City All manufacturing is under the direction of J S Smithson, works manager, but he has under him a factory manager, production manager, purchasing agent, and other staff executives in each of the three factories which he controls

It will be obvious how this plan centralizes control of the three plants and yet makes it possible for each to operate with complete efficiency as an independent unit Even if, in time of war, the home plant and all its personnel should be completely wiped out, the two branch plants would continue to function on their current production programs without interruption In such an unthinkable eventuality it would be necessary, of course, to establish a new executive head office But this could be done at either of the two remaining plants with a minimum of dislocation of the existing program.

At the present time we have three types of aircraft under production in our three different plants With this we have had to act as a schooling agency for the automotive people who are to act as our shadow plant under the B-25 bomber production scheme Since there is such a difference between production methods of the automotive and aircraft industries it has been necessary for a substantial group of General Motors Corp personnel to come to the Inglewood factory for a training period prior to undertaking production of bomber parts and assemblies in their plant. By conducting this factory training school we make sure that production, once underway, will move smoothly and with maximum output.

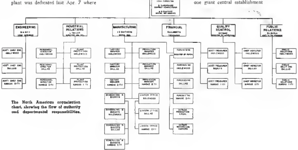
Expansion of our organization from one factory to three has been almost Aladdin-like in its rapidity The Dallas plant was dedicated last Apr 7 where the previous November had been only a cut-over cotton field. Three new AT-6A's were delivered from the plant on the day of its dedication, a full 23 days ahead of schedule. Built in only 120 days, the Dallas plant has now gone to work on a 24-hr day basis producing advanced training planes

Meanwhile we had broken ground on Mar 8 for the $10,000,000 bomber assembly plant at Fairfax Airport, Kansas City Construction of this plant is well along and production is scheduled to start by November Hundreds of men are being trained for the aircraft production work they will then be doing and the organization is being systematically expanded so that it can slip into the production schedule without a jar When the B-25C twin-engine medium bombers begin rolling off the line at Kansas City approximately 60 percent of their parts and subassemblies will have been supplied by the General Motors Corp through the new Defense Unit of the Fisher Body Division Main assemblies to be produced by General Motors include outer wing panels, tail surfaces, fuselage section panels, and nacelle structures As many as 30,000 workers may eventually be employed in fabricating and assembling these planes, with 10,000 of them employed at the Kansas City plant alone. Under the present plans for the Kansas City plant only a few of the tools and jigs will be supplied from our Inglewood factory Most of this material will be built by General Motors from drawings supplied by North American or by the General Motors liaison personnel at the Inglewood plant

Meanwhile our Inglewood plant, having developed the two new factories, and having delivered more than a thousand basic trainers of the Harvard type, is now being shifted primarily to bomber production, with a substantial production also of the new NA-73 pursuit plane for Britain. It is obvious how efficient the branch plant is for simultaneous production of a number of types Unquestionably this scheme makes it possible to produce these different models of aircraft more efficiently, by segregating each in its own factory, than would be possible if we attempted to run all three types through one giant central establishment

Left: A North American B-25 in war paint for the Air Corps. Note tail gunner's position

North American's single-seater pursuit, the XP-51.



The North American organization chart, showing the flow of authority and departmental responsibilities.

Big Boats and Bombers
FROM THE SAME FACTORY

By Edgar N. Gott
Vice President
Consolidated Aircraft Corp

WARPLANES worth nearly a quarter of a million dollars each are rolling steadily off three separate assembly lines at the Consolidated Aircraft Corporation plant here

How this collaboration of parts and equipment, of men and machines, has been achieved is a miracle of industrial ingenuity It isn't so difficult to build small planes of different types but to consistently turn out huge land and sea planes, the smallest of which weighs 14 tons, is no simple task

Consolidated, quietly and skillfully managed by Major Reuben Hollis Fleet, is the fastest growing aircraft company in the country At the beginning of 1940 the company employed 3,170 persons and the plant covered a total of 668,600 square feet By January of 1941 the personnel had been upped to 15,000 and the manufacturing space covered was nearly 3,000,000 sq ft, an increase of 317 percent in working area and 335 percent in personnel

Now a-building are a parts plant in San Diego, just a few blocks from the present factory, and an assembly plant for B-24 bombers, to be operated by Consolidated at Forth Worth, Texas The parts plant will cover approximately the same amount of space as the present factory in San Diego, and the Fort Worth plant will cover some 1,900,000 square feet Employment at the parts plant will be about 15,000 and that at the Fort Worth plant about the same Near the beginning of 1942 if all goes well, Consolidated Aircraft probably will be employing more than 45 000 people to work in factory space covering more than 5 000,000 square feet

The three big planes which Consolidated is turning out en masse are the B-24, four-motored land bomber for the U S Army Air Corps and its counterpart, the Liberator, for the Royal Air Force the PB2Y-2, giant, four-motored sea-bomber, for the U S Navy, and the famed PBY's, Consolidated's 'baby" patrol bombers, which have been used for several years by the Navy as patrol planes because of their tremendous range and speed


The four-engined PB2Y-2 flying boat for the U S Navy

At first glance, one would suspect that producing three huge, different planes would require completely separate tooling, part-manufacture, sub assembly set-ups and final assembly lines However, through foresight and some trial-and-error, Consolidated has been able to cut to a minimum duplication of equipment and labor

Starting with the proposition of attempting to put bomber-manufacture on a mass basis, Consolidated officials have worked out an ingenious collaboration procedure

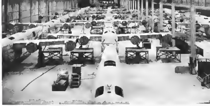
The entire plant has been so constructed as to operate like a Hollywood movie lot. With comparative ease the "set" in one of the huge buildings can be "struck" and in a short time the entire production of that building can be changed from one model to another This is possible because Consolidated planners had the foresight to use clamped pipe joints instead of threaded or welded joints had the foresight to install all lighting ventilation, etc, above the assembly monorails, had the foresight to build doorways and buildings of such dimensions as would accommodate almost any possible plane of-the-future

One of the outstanding elements in Consolidated's set-up is the use of the 50-hour week 20-hour day, with two shifts, rather than three shifts in a 24-hour day The reasons given and proved by Consolidated employment of this arrangement include the fact that it enables the company to spread skilled labor, which is scarce, and also to spread supervision in a plant which now is 16 times larger than it was two years ago It gives the men a two-day week-end in which to recuperate from a hard week's work and it provides an opportunity for the men to earn overtime in case of emergency

The result of using the 50-hour week and 20-hour day plan has been that Consolidated pays for 20 hours and gets 20 hours worth of work while those companies paying for 24 hours work get 22½ hours or less The 10 percent difference in actual work hours is more than made up for in increased plant efficiency These savings in cost are passed on to the customer

So completely have the B-24's and Liberators proven themselves, in actual European combat as well as in test flights made continually at Consolidated's plant, that the U S Army Air Corps has chosen it as the basic bomber for national mass production Plans for the setting up of a vast, nation-wide manufacturing scheme are well under way

The parts of the Consolidated B-24's will be manufactured by the Ford Motor Company in Ypsilanti, Michigan These parts will be shipped to an assembly plant at Fort Worth, Texas (to be directly operated by Consolidated) and one at Tulsa, Oklahoma (to be directly operated by the Douglas Aircraft Corporation) At the two assembly plants the Consolidated B-24's will be put together and flown to terminal points on the Atlantic coast for shipment to the Royal Air Force and for delivery to U S Army Air Corps


The famous B-24 four-engined bombers being built in Consolidated's San Diego plant. Ford will build parts for this plane

The new assembly plants for Consolidated B-24's, at Tulsa and Fort Worth, have been planned along the lines already in use at the Consolidated San Diego factory The two new plants will be practically identical

Each will consist of three main buildings The largest will be the main assembly plant, a building 4000 feet long and 320 feet wide This will contain a continuous assembly line operated on the principle used for many years in the aircraft industry whereby the line has an intermittently timed movement, each airplane progressing from station to station at regular intervals until the completed plane is discharged at the end of the building This assembly line will start with as many as three rows of airplanes in line finishing with a line of single planes having outer wings in place There will be a double railroad siding with crossover tracks permitting delivery of the many carloads of parts and sub-assemblies at the actual point in the assembly line where they are needed

The plants are being constructed to produce at the rate of 50 B24's per month, each However, there may be several months at the beginning of operations when the speed will be below that rate.

The B-24, and its counterpart, the Liberator, are reported to be capable of more than 300 miles per hour and have a range, carrying a full 4-ton load of bombs, of nearly 3000 miles The wing span is 110 feet, length 64 feet, and height of 19 feet The gross weight is 40,000 pounds

Each of the 16,500 of us, who are engaged in turning out these "Guardians of Democracy" is proud of the fact that we are working under conditions and methods which make possible the utmost in precision where it is most needed


A B-24 for England, which the British call the Liberator

You have to see the length of this line and the size of these ships to realize what mass production of flying boats looks like.

PRODUCTION

FOR AMERICA'S PREPAREDNESS AND DEMOCRACY'S PRESERVATION

By F. W. Cnnant

Vice President Manufacturing
Douglas Aircraft Company, Inc

"WINGS for Defense"—Douglas-made—today are rolling off the assembly line in record-breaking numbers

The tempo of pounding rivet guns and droning machines is mounting to a reassuring crescendo, for as the aircraft industry's production lines daily grow longer and move faster they proclaim democracy's preparedness and preservation.

Plans for tremendously accelerated production mapped by Douglas in early days of the defense emergency today are being translated from flow charts and production drawings into airplanes on the wing

Under its huge national defense expansion program, the company is rapidly completing a new $12,000 000 factory at Long Beach, Calif, has broken ground for a $15,000,000 assembly plant at Tulsa Okla, and rapidly added men, machines and working area to its plants at Santa Monica and El Segundo, Calif — all dedicated to the production of the largest possible number of the finest airplanes in the shortest possible time


The Author

To supplement the expansion program and send airplanes down the line faster than ever before shop departments and production lines have been radically rearranged and "streamlined" How successful has been the company's drive for accelerated production is demonstrated by the fact that output as early as January of this year had attained a rate of 150 percent above that of 1939

With orders of unprecedented proportions pouring in throughout the aircraft industry from the United States Army and Navy, and Great Britain, Douglas backlog soared from $72 500-000 at the start of 1940 to well over $400,000,000 by May 1, 1941 In the same period the firm's employment rose from 15,000 to more than 27,000

Plans called for increasing personnel until completion of the expansion program, when employment will exceed 50,000 with an annual payroll estimated at $90,000,000 Rolling off Douglas production lines in ever-increasing numbers are A-20 type attack-bombers for the United States Army Air Corps, and speedy new SBD dive-bombers for the Navy and Marine Corps

At the same time military versions of the famed DC-3 are being delivered to the Army and Navy for use as cargo carriers and troop transports

Already complete is the Army's huge and spectacular B-19 Largest airplane ever built, the super-bomber required more than 2 000,000 man-hours of research, engineering and production work So formidable are the range and striking power of the great ship it is aptly designated the "Hemisphere Defender" in line with America's plans for making democracy secure in our hemisphere

Its wings spreading 212 feet, and powered by four 2000 horsepower Wright-Duplex-Cyclone engines, the B-19 can fly non-stop more than 7700 miles With a phenomenal bomb capacity of 18 tons, it weighs fully loaded more than 82 tons. Upon completion of ground checks and flight tests the B-19 will be turned over to the Air Corps, when it is expected to become a virtual flying laboratory for assembling structural and tactical information and serve as a guide in designing and building tomorrow's giant cargo and troop transports

Under the nation's program of aid-to-Britain, shipments of Douglas DB 7 type attack-bombers have been steadily accelerated Twin-engine, high-wing monoplanes for crew of three, and equipped with self-sealing fuel tanks, armor plating and increased armament, both the A-20 and DB-7 types are designed for use as attack ships or bombers During service in the Royal Air Force, planes of the DB-7 series, known as "Bostons" and "Havocs" have been found so fast and maneuverable they have also been put to use as interceptors and night fighters

For production at its Long Beach plant, Douglas has signed contracts with the government for large numbers of A-20B attack-bombers and C-47 military transports, while in the Tulsa factory it will assemble Consolidated B-24D four-engine long-range bombers

Its construction now underway at full speed, the Tulsa plant brings Douglas, the Ford Motor Co., and Consolidated Aircraft into a "partnership for preparedness." The vast experience and resources of all three are to be co-

(*turn to page* 154)

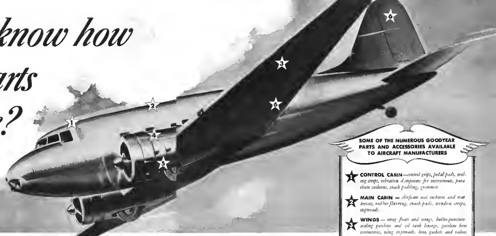
Below: DB-7B's for Britain and A-20A's for U. S. move along a final assembly line


Over 27,000 Douglas employes keep production rolling for 24 hours a day to whittle down the $400,000,000 backlog


The Douglas plant is now so large that aisles are marked with names of streets and avenues. Electric truck-trailer trains operate on regular schedules.


Wing and fuselage sections for Douglas bombers are moved along on the conveyor trucks shown here Production engineers have speeded manufacture in many ways.

Do you know how many parts we make?



SOME OF THE NUMEROUS GOODYEAR PARTS AND ACCESSORIES AVAILABLE TO AIRCRAFT MANUFACTURERS

- 1 **CONTROL CABIN**—*control grips, pedal pads, sealing strips, vibration dampeners for instruments, parachute cushions, crash padding, grommets*
- 2 **MAIN CABIN** — *Airfoam seat cushions and mattresses, rubber flooring, crash pads, window strips, steptreads*
- 3 **WINGS** — *wing floats and wings, bullet-puncture sealing gasoline and oil tank linings, gasoline hose connections, wing steptreads, hose, gaskets and valves for hydraulic controls*
- 4 **MOTORS** — *vibration dampener mounts, bullet-puncture-sealing gasoline feed hose.*
- 5 **LANDING GEAR** — *magnesium- and aluminum-alloy wheels, hydraulic disc brakes, tires, tubes, Dual-Seal tubes for nosewheels, brake sealing rings and gaskets, hydraulic brake control hose, retracting gear hose, valves and gaskets*
- 6 **COMPLETE ALL-METAL AND FABRIC-COVERED SUBASSEMBLIES** — *wings, nacelles, floats, tail and other surfaces*

For upwards of thirty years Goodyear has been known to aviation as a foremost supplier of airplane tires, tubes, wheels, brakes and many other accessories.

We are also now manufacturing many highly specialized new rubber products essential to modern military aviation, including bullet-puncture-sealing linings for gasoline and oil tanks, and bullet-puncture-sealing gasoline feed hose.

And beyond this, our subsidiary Goodyear Aircraft Corporation is now applying its long experience in aeronautical engineering to the construction of wings, tail and other surfaces — on subcontract for primary airplane manufacturers.

Because experience, dependability and service count more than ever today in expediting the nation's aviation program, aircraft manufacturers are finding our mass-production facilities invaluable in easing their load.

The quality of Goodyear aviation products is evident from the fact that Goodyear is the nation's leading supplier of rubber accessories and related metal parts for aircraft — both commercial and military.

Thus, to the aviation industry Goodyear offers the same service it has extended for many years to both automobile and truck manufacturers, that of a dependable mass-producer of parts and accessories—on a larger scale than ever before.

Airfoam—T.M. The Goodyear Tire & Rubber Company

GOODYEAR

ON YOUR NEW SHIP SPECIFY GOODYEAR AIRPLANE TIRES, TUBES, WHEELS AND BRAKES

One of Vought-Sikorsky's Taylor-Winfield Hi-Wave machines in operation

By Charles W. Dodge
Spotwelding Engineer
Vought-Sikorsky Aircraft Division
United Aircraft Corporation

DESIGN OF SPOTWELDED STRUCTURES

WITH the advent of the defense expansion program the production problems which were previously only in the minds of engineers were suddenly brought into reality Faced with the tremendous task of immediately increasing production, repercussive effects were felt in practically every phase of the aircraft industry and brought to the foreground production methods which, although satisfactory for our peace time needs, were inadequate for such a program

One such production method was the joining of aircraft structures by riveting which had long been recognized as being slow because of the tremendous amount of manual labor needed Searching for a more efficient method of fabrication, Vought-Sikorsky several years ago, turned to welding This process for some time was known to offer distinct benefits, but was ruled out because of the lack of knowledge and equipment to overcome certain obstacles After a considerable amount of research and lengthy experimentation the important stumbling blocks were overcome Soon after that Vought-Sikorsky found itself not only welding small parts for air planes but primary structures as well

When once the process had been developed it was necessary to acquaint the engineering department and the shop with this new tool After considerable studying an engineering and shop technique was devised which is today rigidly followed in design and fabrication for aluminum spotwelding

Previously, riveting, being the most commonly used method of joining aluminum alloys, had necessitated the accumulation of considerable data and experience for successful shop use. In fact, so much had been gathered that it was no longer a problem but rather a process, the limiting factors of which had given standard minimums and maximums With the advent of spotwelding and by use of special technique and equipment, comparable results are being obtained with a subsequent reduction in cost, simplification of assembly, and better finished appearance

Spotwelding Process

Spotwelding is accomplished by clamping on two or more sheets of metal between copper or copper alloy electrodes under comparatively high pressure, and causing an electric current of low voltage to flow between the electrodes for a predetermined time interval (See Fig 1) The current creates an intense heat at point "A" (See Fig 2) which melts the metal locally due to the resistance set up by the sheets As soon as the metal is molten to the extent shown at "B" the predetermined time of current flow is completed and the sheets are forged together by the pressure on the electrodes "P". This pressure depends on the thickness of the sheet (See Fig 1) To accomplish this and make an accurate weld the usual practice is to use one dome-shaped electrode of the upper or movable arm and one flat electrode on the lower or fixed arm.

Equipment Used

Three types of machines that give accurate current flow and pressure are used These types are standard AC controlled, storage of energy by inductance and storage of energy by capacitance As for the mechanical portions of the operation they are fully automatic, air operated with electrical sequencing The spotwelding machines are the rocker arm type and the press type, the difference being in the flexibility of electrode arrangements and rigidity of the arms The rocker arm welders are more flexible than the other type. Size of panels which may be welded is determined by dimensions of the machine.

Using these machines there are certain limitations in dimensions of panels which can be processed. Panels as long as 15 ft. and as wide as 60 in. can readily be spotwelded without special fixtures. However, assemblies exceeding these limitations require special consideration As for thickness, the equipment will successfully weld in composite thickness of two or more sheets of aluminum alloy from the 020 in minimum to 182 in maximum, (such as two sheets of 010 in. or two sheets of 091 in.)

Materials for Spotwelding

As a general statement, any of the existing aluminum alloys may be spotwelded, and alloys of different physical and mechanical analysis may be welded to each other interchangeably However, certain combinations of materials do give better results and, listed in order of preference, these combinations are

24ST Alclad	
24SRT Alclad	53SW or T
17ST Alclad	24SO Alclad
17SRT Alclad	17SO Alclad
3SH	3SO
3SI/2H	52SO
	53SO
52SH	2SO or H
52SI/2H	

The use of soft alloys 3SO, 52SO, 24SO Alclad, etc, is not recommended, as satisfactory results are difficult to obtain This is because the high welding pressures necessary are apt to create badly deformed surfaces on these materials

Design for Accessibility

Primary in the design of spotwelded parts is the factor of accessibility. Although special tools can usually be made for inaccessible places, the necessity for fixtures tends to defeat the economy purpose of spotwelding and should be avoided wherever possible As a guide for making parts accessible the minimum dimensions for typical

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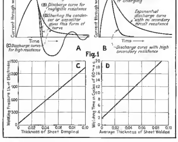
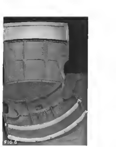


Fig. 1 Curve "A" above shows current time curves for operations of discharge of condenser type of spotwelding machine while curve "B" is for the operation of inductance coil type spotwelding machine. "C" below shows that the welding pressure and electrode is directly proportional to thickness of sheet in contact with upper electrode "D" shows that the welding time is proportional to the average thickness of the sheets being welded together.



Typical engine cowl panels with "Z" sections facilitating straight rigid spotweld set-ups.

The spotweld rolling machine, designed and made at Vought-Sikorsky, is air-operated and motor-driven.

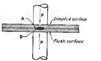


Fig.2

Vultee's latest product, the P-48

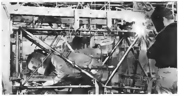
Getting 'em Into The Blue
AHEAD OF SCHEDULE

How Vultee Builds Basic Trainers

By R. A. Lawson, *Works Manager, Vultee Field Division Vultee Aircraft, Inc.*

AT Vultee we have adopted a slogan which is symbolic of our determination to deliver the airplanes on schedule It is "Get 'em into the Blue." That may seem pretty obvious Certainly no airplane is an airplane until it is up in the air—into the blue sky But the method for getting them there is not so obvious And in this day of plans piled upon plans until it sometimes seems we have more plans than planes, it is important to observe that there is no easy solution to our aircraft production problem There is no single magic formula waiting to be discovered—no "Get rich quick" method of hitting the production jackpot

What some people, even production people, sometimes overlook is that all production is based on men Machines are essential it is true, but first we must have men who are willing and able to design the machines to build them, to operate them efficiently It we have succeeded with our production problem at Vultee it is because we appreciate that primarily we are working with men rather than with machines, or with plans These men are all part of a team Some are given one responsibility and some another, all in accordance with their abilities as best we can determine them Whatever their jobs, we expect these men to handle them efficiently and without shifting the load to others in the production team We are sparing with our praise because we expect every man to do his job well It does not require a national defense emergency to bring out a man's best efforts Pure self interest will prompt each individual to do his best with his work once he understands what is expected of him He knows that life's material rewards come to those who deserve them and so he does not expect to be coddled and back-slapped into doing what he should do for his own sake, as well as for that of his company and his country



Vultee has pioneered in electric arc welding of major fuselage structures.

In some respects the problem of getting production out of a team of factory workers is a lot like training a football team to play winning football Many coaches spend a life-time trying to figure out trick plays with which to flim-flam the opposition. But winning teams are usually coached by men who follow Knute Rockne's philosophy expressed in the following sentence "Every play is a touchdown play if every man on the team does his part perfectly" We know that it is not the play which counts so much as the way it is executed So we have devoted our first and greatest effort to getting our men to "play ball" all up and down the production line

That this policy is correct is indicated by the fact that we finished our first Army contract for 300 basic trainers substantially ahead of schedule And on the same day that we delivered the final airplane on that contract we also delivered the first basic trainer of the new contract. We are building a much larger number of basic training planes on this new contract; in fact it is the largest single order in point of units involved ever placed by the U S Army Air Corps. And during March and April we exceeded the requirements of our contract schedule by more than 30 percent and are holding this high rate of output at the time this article is written

In achieving such production we have tried to keep well balanced in the efforts and attention given to all our various problems As indicated earlier, we have recognized that our first and most important problem was that of men The scope of this article will not permit a full discussion of our Industrial Relations department But the reader may be sure that we have used the best possible methods for selecting our new employees and for training them and encouraging them to advance in their work

Once the men have been provided for the production effort we may turn to an examination of specific methods There are two general lines of attack on the production problem and we have proceeded along both One is to design planes in such a way that they lend themselves to production The other is to develop special machines, jigs, fixtures, tools and methods to speed the production process

Even before production engineering commences it is possible to reduce the production time materially This is done by streamlining the engineering and design work Obviously it is not possible to start production until we know what we are going to produce It used to take a couple of years to engineer and build the first prototype plane, run it through flight testing, re-design it and finally put it into production The present emergency does not permit of such a leisurely approach to the problem and many precious months have been saved by a change in procurement practices which permits purchasing planes direct from blue prints and specifications, ordering full production to start at once This scheme completely eliminates the prototype Therefore, to make sure that "streamlined" engineering does not result in the pro-

(turn to page 162)

BT-13's on the final assembly line at Downey


AMERICAN AIRLINES
FLAGSHIP FT WORTH
Flagship Skysleeper
ACROTORQUE
PAT. PENDING. U.S. AND FOREIGN
TYPE
MODEL
SERIAL
ORDER
MFRS. DWG.
CONTRACT
SPEC.
DATE
MAX. PRESS.
P.S.I.
THE ACROTORQUE CO., CLEVELAND, O.
MADE IN U.S.A.

Behind the Scenes at NACA

Newest of NACA laboratories is now being built at the Cleveland airport. This will give the committee three large laboratories in different parts of the country. Buildings shown here are a model.

The full story of N.A.C.A. must not be told until after the war. but here is an important part that can be discussed freely at this time.

By S. Paul Johnston

Coordinator of Research, NACA

TO most people "NACA" means only wind tunnels, towing tanks and engine laboratories. It also stands for an organization of almost a thousand men and women who are spending their lives and their best efforts to make military aircraft more efficient and commercial aircraft safer. But it is, above all else, a key symbol today in the current pattern for national defense.

The full story of what goes on today at NACA's Langley and Ames Laboratories must wait a while for the telling. The most that can be said at the moment is that for 24 hours of every day the tunnels and the tanks and the test stands are checking and rechecking, proving and revising the planes and the engines that are essential to our war effort. For obvious reasons few visitors are permitted behind the scenes. For the same reasons it can be easily understood why most reports covering tests and experiments are stamped "confidential" and kept under lock and key in Army and Navy files. Some day the lid may be lifted. Some day the results of tireless and continuous work may be published. When that day comes, the taxpayers of the United States will realize what a tremendous return they are receiving for every dollar spent on aeronautical research.

But apart from its actual laboratory work, the NACA carries on many other equally important and far-reaching activities. It is one of the most important clearing houses for aeronautical information of all sorts gathered in this country and from abroad for the benefit of the armed services and the aviation industry. In the Office of Aeronautical Intelligence a complete library on every possible branch of the aeronautic art is available. It is from the OAI that the publications of the NACA are issued—Technical Reports, Technical Notes, Technical Memorandums, etc. During the period of the emergency the distribution of these publications has been of necessity restricted, but they are always available to engineers and designers of airplanes, engines, and accessories who need the information they contain. Advance Confidential Reports are issued to the contractors who are building Army and Navy aircraft, so they may be kept constantly informed on the latest test results from NACA laboratories. Further, such people keep up to data on research results by frequent visits to Langley and Ames for direct consultation with the men who are doing the jobs.

The make-up and functions of the National Advisory Committee for Aeronautics itself are well known to readers of AVIATION. They have been covered before in these pages. Less is generally known, however, about the subcommittees of NACA and how they work. There are four main technical committees subordinate in function to the main committee. They deal with Aerodynamics, Power Plants, Structures, and Materials. Each is headed by one of the members of the NACA. Each has subordinate to it certain subsubcommittees which deal with special branches of the main topic. For example, Aerodynamics has under its wing the specialized subjects of airships, meteorological problems, seaplanes, vibration and flutter, and, more recently, propellers, rotating wing aircraft, and wing and windshield deicing. The Power Plants Committee has the next largest group with subdivisions covering fuels and lubricants, supercharger compressors, exhaust gas turbines and inter-coolers, and a special subcommittee on induction system de-icing. Under Materials are but two main divisions, a subcommittee on metals used in aircraft (which deals in both ferrous and non-ferrous materials) and a subcommittee on miscellaneous materials and accessories. Only recently a special group has been set up to make a study of general welding problems. The Structures group has no regular standing subcommittees. There are two special groups, however, that have been detailed to make a survey of the technique and equipment for elastic examination of large aircraft structures in lieu of destruction tests, and the other, to direct research in applied structures. A distinction must be made (in considering committee organizations) between standing committees and groups set up on a temporary basis to consider special problems and which disband when their particular job is accomplished.

Within the past year the subcommittee work of the NACA has been on a constantly expanding scale. A number of the groups mentioned in the preceding paragraphs are of quite recent origin. In most cases, the make-up of the committees has been restudied, and a number of new appointments have been made. Where several years ago, subcommittee personnel was drawn from governmental agencies exclusively, today each subcommittee has on its roster an appreciable percentage of civilian experts—the men from every branch of aeronautics and the allied industries who are most highly qualified to deal with each particular subject. Most of them hold key positions in important manufacturing organizations. They are all extremely busy, but they take time out to come to Washington as often as necessary to contribute what they can in the common interest. These men serve the committees without compensation, not as representatives of their particular companies, but as individuals who by reason of long experience are expert in their fields. Altogether, some 160 individuals now make up the membership of NACA subcommittees. In order to bring new experience to bear on problems before these committees, it is a policy of NACA to maintain a certain turnover of membership every year. It is for that reason that all appointments are now made on an annual basis.

There is a big glass topped table in Room 3841 of the Navy Building in Washington that has become a focal point for aeronautical defense activities. Several times every week one or another of the NACA committees is sitting about that table, tossing back and forth urgent problems that have been posed by the services and by industry. These discussions have but one purpose—the improvement of the airplane as a weapon of war or as a carrier of commerce. They deal with methods to develop airplane performance, better materials, better structures, more efficient fuels, or lubricants, better means of de-icing engines or wings, or the betterment of a hundred other items too numerous to catalog. Not a single subject that has any bearing on the supply of efficient fighting aircraft for our Army or Navy but gets a thorough workout from all angles.

Most important, the deliberations and decisions of these committees are not simply put down on paper and stored away in the archives. Engineering officers from the Army and Navy sit on the committees and get, first hand, the considered opinion of expert minds. Frequently members of the staff of the Office of Production Management attend meetings to ensure that the men who are directing the great procurement programs are continuously aware of the technical problems that are involved. All these men take away with them correct answers to pressing problems, in shape for immediate application. For example, a fuel problem may be settled today in committee. Tomorrow it is translated into service orders, and the next day it goes into a modified specification for the refineries or into revised instructions for the forces in the field.

In order to provide the most effective cooperation with the NACA divisions charged with aeronautical research, both the Director of Research, Dr. George W. Lewis, and the Coordinator of Research, S. Paul Johnston, sit with every technical committee. Thus, Dr. Lewis is constantly informed of the wishes of industry and of the Army and Navy with respect to their major research problems. Thus the work in the Langley and Ames laboratories may be kept constantly up to the minute. In the same way, the coordinator can obtain the directives he needs for the proper conduct of negotiations with universities and industrial laboratories on outside research projects.

Work in outside laboratories is becoming of increasing importance. Prior to fiscal 1941 only $25,000 was available for the support of aeronautical research in universities. During the current year, however, the amount allocated by Congress was $120,000 and for fiscal 1942 it has been boosted to $150,000. This year some 30 independent projects have been contracted for in 15 university laboratories to supplement the work at Langley and at Ames. Correlation of these projects with the general research program of the committee is taken care of in the coordination office and in the discussions before the several subcommittees as they approve the granting of university contracts. No over-lapping is allowed, either on NACA projects or on research programs in other universities. Also, first priority is given to research proposals that deal with problems of importance to national defense.

S Paul Johnston

The projects for which university contracts are written are of the same general class as those handled by the NACA laboratories. They are limited of course by the capacity of equipment available at universities. Surveys have been made of all schools in the country where research work may be done, and the capacity and the interests of their laboratories and faculties are now reasonably well known. Obviously, no university in the country can afford wind tunnels or towing basins on a scale comparable to those at Langley or at Ames, but there are many fundamental problems in many fields allied to aeronautics that can be handled economically by educational institutions.

A few examples taken at random from the list of current contracts will illustrate the sort of work that is being done. California Institute of Technology has several studies under way on turbulence and boundary layer phenomena and is carrying on an elaborate investigation of instability criteria for monocoque structures. Case School at Cleveland is also working on a boundary layer problem and is investigating certain stress measurements in materials by the use of X-rays. University of Illinois is looking into fatigue properties of aluminum alloys used in propeller blades. University of Maryland is working on several structural problems and on a diesel engine project. Massachusetts Institute of Technology has a number of researches under way on airplane engine design and performance. Michigan is looking into the strength of plastics. New Mexico is dealing with the structure of thunderstorms. Stanford University is specializing in propeller investigations and structural research. One of the most interesting and important projects is a joint investigation of the spot welding of aluminum alloys sponsored by NACA and by the Army and Navy at Rensselaer Polytechnic Institute. This list is far from complete, but it gives some notion of the catholocity of the subject matter with which University researchers are dealing.

Heretofore initiative for suggesting research projects has rested largely with the universities. Their research people have submitted problems to NACA which they themselves wanted to investigate. In many cases, however, the NACA laboratories had already solved the problem or other schools were known to be at work along similar lines.

To correct this condition, and to expedite the placing of contracts with universities on problems of vital interest, the NACA is now taking more of the initiative by pre-selecting projects which are considered desirable for university attention. Several months ago the coordinator asked each subcommittee member to make suggestions for desirable research problems for allocation to universities. Each committee

(Turn to page 160)

Aluminum and Magnesium

How much will we need in the next 12 months?

By Raymond Hoadley

OF all the strategic metals of which short supplies worry the defense industries, only aluminum and magnesium provide major headaches for the aircraft manufacturer. But ironically, the shortage in these two vital metals is the most acute of any of the defense materials. Fortunately the aircraft industry has first call under the priorities system on both these items. Even so, a lack of fabricating facilities often holds up the flow of aluminum from reduction plant to the aircraft assembly line, and supplies of magnesium are, and for many months will continue to be, insufficient for all military aircraft needs.

Last fall it was thought in Washington that there would be enough aluminum for all demands, both defense and civilian, aside from occasional tight spots. Three months ago the authorities felt that 50 percent of the nondefense aluminum consumption could be taken care of this year. Today the kitchenware concerns, automobile trade and other peacetime users are being told as gently as possible that military needs—chiefly aircraft—will consume practically all of the white metal output indefinitely.

This is the way the situation stacks up at present. January aluminum output totaled 25,000,000 pounds. Currently it is running about 50,000,000 pounds with an additional 5,000,000 coming in next month. More would be available early in the summer except for the five week Allis Chalmers strike which delayed shipment of equipment to both the Aluminum Company of America and Reynolds Metals Company, the sole aluminum producers in this country. However, it is expected that production can be stepped up to around 75,000,000 by the end of 1941.

On the consumption side aircraft's aluminum "take" in April totaled well above 40,000,000 pounds as against a production for that month of 48,000,000 pounds. A confidential survey by defense officials is understood to show that aluminum requirements for aircraft will show a steady increase of around 10 percent a month hereafter. Thus this schedule of rising aircraft use of this raw material indicates a steady increase in plane deliveries from 1,200 in April to 2,000, roughly, in August.

This same survey shows that the flow of aluminum to aircraft factories will mount to 75,000,000 pounds a month by the spring of 1942—an amount approximately twice the consumption demand from all industry for this metal in 1940. And by that time the President's new bomber program also will be about to step into the supply-demand picture for this defense metal. That means more expansion in aluminum making facilities and promptly.

The dollar-a-year defense officials have seen their estimates of aircraft requirements thrown out of joint so often by new supplementary national defense or lease-lend projects that they have determined on an "all-out" aluminum expansion that will triple current production and bring aluminum output eventually to around 1,500,000,000 pounds annually, as against the 412,500,000 1940 total.

Meanwhile, Canadian aluminum production is no longer sufficient to supply all the wartime needs of Great Britain despite the fact that virtually all the Dominion's large output of this metal has been reserved for armament purposes for many months. Therefore it is understood on high authority that the Office of Production Management has agreed to allot nearly 2,000,000 pounds of aluminum a month to Great Britain for the next fifteen months.

Taking into consideration both the domestic aircraft and British export needs over the next year, defense officials feel confident that the supply will be sufficient for these purposes, barring labor troubles, expansion delays or, perhaps more important, drought-imposed curtailment of power supply.

No wonder the aluminum producers are praying for rain this year for it takes lots of power to make the wheels go 'round in an aluminum plant. Already the Aluminum Company is expending $200,000,000 of its own funds on plant expansion while Reynolds Metals has secured loans of $20,000,000 from the government to enable it to enter the aluminum ingot field.

In magnesium the situation is less encouraging. Despite Dow Chemical Company's four-fold expansion in this lightest-of-all metals since 1939, there is not enough magnesium for the aircraft industry now or in the near future. Defense officials were forced to take control of magnesium distribution in February. At that time it was realized that Great Britain had financed some of the recent magnesium plant expansion here and planned to import a considerable amount of the metal.

In March, however, British agents dropped a bombshell in the defense camp by urgently requesting a far greater share of the total output (nearly 50 percent) than the Washington authorities had any idea they would need. The British explained that it was needed for the new incendiary bomb which now is being used over Germany—apparenlty with good results. Most of the metal requested, although not all, was allocated to the embattled Isles and as a consequence aircraft makers may have to substitute aluminum for magnesium in such parts as landing wheels and gears.

Dow Chemical will have its second new plant in operation at Freeport, Texas, this fall, extracting magnesium from seawater—one of the great chemical achievements of the age—as it does in Michigan from brine. But the demand grows faster than the supply.

Now defense officials are talking in terms of an ultimate magnesium capacity of 150,000,000 pounds, as compared with the 25,000,000 pounds scheduled production for 1941. And in 1938, when 4,000,000 pounds were produced magnesium was a drug on the market.

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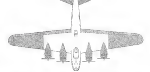
248 FACTORIES BUILD THE FLYING FORTRESS

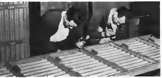
Boeing has been a leader in sub-contracting. This is the story of its affiliated firms and what they produce for the Boeing bomber.



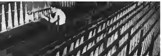
The shaded portions of the drawing show the parts of the Flying Fortress that are built by Boeing sub-contractors.

Engine nacelles are built by Northrop Aircraft at Hawthorne, Calif These four are enough for just one B 17.

Briggs of Detroit forms these heavy dural hat sections which will become compression rib chord members.



Boeing inspectors check alignment of wing fuel tank doors, also made by Briggs, one of Boeing's largest sub-contractors.



Left: Wing flaps are also among the parts turned out by Briggs. These aluminum alloy parts come in by the car load.

IT takes two hundred and forty-eight factories to make a Flying Fortress.

Plants in 80 cities scattered throughout the United States are now contributing to the vastly increasing production of these famous 4-engine bombers for the U S Army Air Corps and the Royal Air Force Some 193 of these plants supply the thousands of standard equipment items and parts installed in each ship The remaining 55 are subcontractors, now sharing the work of manufacturing major parts and subassemblies of the actual airplane.

The Boeing Aircraft Company of Seattle, headquarters of this all-American production team, has been cited as an outstanding example of successful application of the subcontracting process, which is strongly recommended by the Office of Production Management as a means of quickly accelerating the national defense program By spreading the work over a number of existing plants, large and small, it has been possible to make immediate use of ready production equipment and qualified man power in various parts of the country and thus short-cut the task of speeding production

While Boeing's plant expansion program has been going on, outside producers have been working all the while on their own portions of the extensive Boeing orders As a result of this far-sighted planning, finished manufactured parts for a new Flying Fortress model are now regularly flowing into the main factory at Seattle from sources in all directions, while the Seattle factory is getting under way with its own quantity production of this model

Boeing began many months ago to develop new sources of supply in anticipation of increased Flying Fortress production At that time the company began placing "educational" orders for various parts normally manufactured in the Boeing plant in order that these outside suppliers might become acquainted with the technique of aircraft production work Insofar as possible, these "helper" plants were selected in or near Seattle in order that they might be properly coached in the work Meanwhile, Boeing contacted other plants in more distant sections of the country to determine what would be their capabilities as subcontractors The most promising of these were invited to send their representatives to Seattle and, at the same time, Boeing field representatives visited and surveyed the plants of the prospective subcontractors By the time government requirements for increased production were voiced, Boeing was ready with a selected, tentative list of plants to which it could turn for assistance.

An outstanding feature of the Boeing program has been the farming out of major sub-assemblies rather than merely individual parts Whole sections of the airplane are now being produced in completed form in outside plants and shipped to the Boeing Company for final assembly The largest of these are built at a newly constructed plant of Boeing's, Stearman Aircraft Division in Wichita, Kansas. Here the complete tail surfaces are fabricated and assembled as are the outer wing panels and wing tips Other major parts now handled outside of Boeing's factory include the entire engine nacelles, engine cowling, wing flaps, landing gear, fuel tank compartment doors, fuselage circumferentials, and numerous machined parts Boeing's own production is concentrated mainly on fuselages, inboard wing panels, and final assembly Today approximately 30% of the Flying Fortress is built on the outside, as compared with 3% a year ago

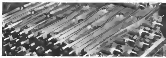
This outside production, Boeing officials declare, is enabling the company to make accelerated production schedules that otherwise would have been impossible Especially has this been true in the case of machined parts Because of the difficulty in obtaining rapid delivery of new machine tool equipment and the scarcity of additional experienced machinists, it has been particularly helpful to be able to make use of the equipment and manpower of existing machine shops, which were qualified for defense production, but were formerly occupied with other types of manufacture By "farming out" as much of the machining work as possible, the Boeing Company has been able to relieve the load on its own greatly-enlarged machine shop, leaving the home shop in a better position to handle last-minute design changes, late production releases, "cut and try" items, and "blitzkrieg" items, which must be rushed through to hurried completion in order to prevent delays in other parts of the factory's intricately coordinated production schedule. Likewise the program has been helpful in reducing the overload on tooling facilities, which are hard pressed during expansion

A staff of 143 persons is now at work in the Boeing Purchasing and Material Control Department, handling the meticulous job of purchasing and receiving the thousands of parts produced on the outside, including both the standard parts, which come from regular aircraft equipment manufacturers, and the parts produced for Boeing by its own subcontractors Twenty persons are assigned completely to the job of dealing with subcontractors and following-up the coordinating their efforts Six of these are Boeing representatives stationed at some of the larger subcontracting plants

In arranging an outside production program for a new airplane contract, the Company management first determines in a general way the amount of work required to be "farmed out" in order to meet schedules within the limita-

(*Turn to page* 176)

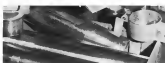
Right: Kenworth Motor Co., Seattle and Iron Fireman Portland, machine these retainer assemblies for bomb door controls.



Pacific Car & Foundry produce these landing gear strut braces. They are stacked here awaiting Magnaflux inspection at Seattle

The Iron Fireman Mfg Co of Portland Ore., is a major subcontractor. Among parts made are these landing gear supports.

Flap control brackets, being checked here by a Boeing receiving store inspector, are made by A W Hecker Co., Cleveland.



Three landing gear strut cells are made by the National Supply Co. of Torrance, Calif. All parts are checked with drawings.

Sperry Lets George Do It

But before George, the Sub-Contractor, can turn out production items, he must first be found, then trained, and then taken into the Sperry Gyroscope family. Outside firms are now turning out a quarter-million machine hours per month for Sperry, but much toil and sweat have gone into the process.

By Carl Norcross *Managing Editor, Aviation*

"WE cut plenty of gears before Sperry came along," said Tony Failla. "We'd cut 'em big and we'd cut 'em small, and we thought we were pretty good. Plenty of prints from which we worked showed tolerances of a thousandth or less, and we thought the first Sperry order was just more of the same."

He reached into his desk drawer and took out two gears so small they didn't crowd each other in the palm of his hand.

"See these?" he asked. "They look alike to you—and to me, too. But they aren't alike. Only a Parkson Gear Tester shows this one has a pitch diameter that is 001 too great to meet tolerances for a directional gyro. This other one is OK. For nearly seven months we sweat over gears like these. We'd send 'em to Sperry and the inspectors would reject every one. We'd sweat some more and send over another batch—and back they'd come."

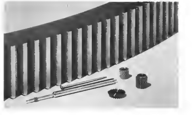
He sighed. "We found we weren't so hot. On Sperry prints when limits were set at a thousandth, they meant a thousandth and there were inspectors to check the limits. No other firm we had worked for ever knew if tolerances were being met. So we had to get checking equipment. Sperry methods engineers came into the shop. They worked with us. We had good men and good machines, but we learned to get better work from both. Month by month we began to lick the problem. Rejects got less and less. Now we turn out 1100 different types and sizes of gears and our rejects are less than one percent."

The story of Tony Failla and the New Jersey Gear Company is typical of most of Sperry Gyroscope Company's 50 sub-contractors. It is a story of toil and sweat, of pushing both men and machine tools to limits they had never met before, of long hours and a mountainous pile of rejected parts which gradually grew smaller and smaller. It is also a story of how a firm playing a critical role in national defense was able to expand ten-fold its output of such significant items as aircraft instruments, sound locators and other anti-aircraft and combat equipment.

Sub-contracting is one of the great problems of national defense—and Sperry has gone a long way toward finding the answers to that phase of its production problems. The story of Sperry's sub-contracting is not typical of all sub-contracting but the underlying basis is the same. If Sperry can find and train manufacturers of such widely different products as cream separators and sewing machines to turn out parts for precision instruments and for anti-aircraft detectors, the defense manufacturer of less complex products should be convinced that *his* sub-contracting problems are not insurmountable.

To everyone connected with aviation, the name Sperry stands for precision products. The directional gyro and the artificial-horizon are not Sperry's most complicated mechanisms, yet the two have 300 parts. Of these, 100 are standard items that can be purchased outside but which must meet Sperry standards. Fifty parts require no great precision manufacture, but all the remaining 150 parts are made to close tolerances—half to measurements of 001, and half to 0005. And as Tony Failla emphasized, tolerances are held to the fanatically fine leeways allowed on the drawings. In all its products, Sperry requires from 60,000 to 70,000 distinct parts.

Gears are one of its most difficult sub-contracting part. You may believe the gears in your $100 watch are a pretty nice piece of work, but they were child's play to cut compared with Sperry gears, many of which are made for variable speed drives. There is considerable play between the gears of a fine watch. There can be no play or back-lash in the gears of Sperry devices. Measurements on gears shown in the accompanying photograph are of an almost unbelievable fineness.



Largest and smallest gears sub-contracted are shown here, with a common pin for comparative size. The gear at the extreme right has a pitch diameter with tolerances of 001 and tolerances on the balance of this gear are 0002 of an inch.

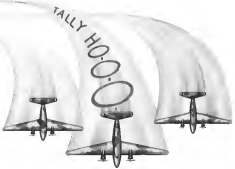
There are many gears in the products Sperry manufactures—and finding outside firms that can cut gears is an extremely difficult job for Sperry's sub-contracting department. Here are a few of the 1100 types and sizes built by one sub-contractor. Each requires the highest type of precision work.

Sperry history in farming out its work is especially pertinent at this time because this firm started its sub-contracting four years ago. The problems it has met are typical of those many firms are now encountering for the first time. Working closely with the procurement branches of the Army and Navy, Sperry made a survey of some 1,000 firms in the general area of New York City in the spring of 1937. Most of the names secured were discarded after an inspection by Sperry engineers disclosed that they were not satisfactory. A few organizations seemed to offer possibilities, and the first sub-contracting order was given in June 1937,

(Turn to page 168)

THE SPERRY CREED FOR SUB-CONTRACTING

1. Schedule the amount and types of your sub-contracting as far in the future as possible.
2. In surveys of potential plants, secure complete information on size of building, type of machines, kind of product being made, skill of personnel available, output, possibilities for expansion.
3. When you have chosen your sub-contractors, provide them with as much help as though they were new departments of your own company.
4. Provide complete blueprints, job sheets and cost sheets. Don't hold back any manufacturing secrets.
5. Set a fair price, preferably a cost-plus basis on early orders. Your sub-contractor must make a profit to stay with you. Admit to yourself that there is always considerable scrap on early orders.
6. Lend or help to secure for your sub-contractor if necessary any tools or new equipment he may need.
7. Give freely of your supervisory help. Send in methods engineers and shop men who have the "know how" on the product to be made.
8. Keep complete machine charts as to work done and work on order. Watch for bottlenecks in methods and materials.
9. Help your sub-contractor with training and personnel problems if needed.
10. Remember that educational orders may be necessary for six months on difficult work.
11. Follow-through on every production detail.
12. Don't be over optimistic as to early results. Sub-contracting is a long, tough job.



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Above the whining carrier-wave of the squadron-leader's transmitter comes the word you've been waiting for . . . "Tally-Ho!" ***Over you go, my lad, peeling off, one by one, and down, down, down . . .*** **Can the old kite take it? Right! She's American-built . . .** ***down . . . down some more . . . the controls grow stiff with speed*** **. . . But they'll be sweet on the pull-out, and keen as fiddle-strings, going home . . .**

Yes, she's got a rough trip from Newfoundland already under her belt when she's delivered, but these ships America is building for the R. A. F. are sensitive and responsive to control, at fifty hours, or five thousand. *Every one* of them—like *every* U. S. Army ship, *every* U. S. Navy ship and *every* U. S. airliner—carries Fafnir Aircraft Ball Bearings at important points of motion.

The only reason you put ball bearings in a control system is to gain the advantages that only ball bearings can bring. Rigidity, without friction. Tightness, without binding or wear. Minimum maintenance and adjustment.

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The cost of the finest aircraft ball bearings is so insignificant a part of the ship's total cost that you can letter "Fafnir" at the right spots, right on your sketches, without unbalancing the budget. The Fafnir Bearing Company, Aircraft Div., New Britain, Conn.

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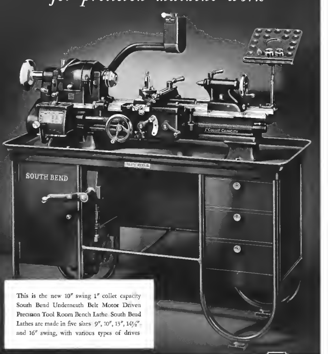


Aviation

RADIO

Dialing the Air Waves with Craig Walsh

Braniff Airways Installs Automatic Direction Finder

Braniff Airways has just completed the installation of Sperry Dual automatic direction finders on its fleet of 21-passenger Super-B liners and thus becomes the first airline to make use of this newest contribution of radio to safe and sure air navigation. A dependable and automatic determination of an airplane's position is provided by tuning in two radio stations. With the locations of the two radio transmitters known, the deflections of the two pointers on the dial of the dual direction finder indicate the position of the plane. It is not necessary that the transmitters be the airline beam transmitters, but any station on any frequency will do, as long as the receiver picks it up.

This new instrument is a combination of two direction finders with a single indicating scale. There are two pointers on the scale, each controlled by its radio receiver. Each unit operates independently of the other, and as in the original single unit, each pointer points in the direction of the station tuned in. Knowing the positions of the two transmitters, by means of their call letters, and observing the position of the pointers, the pilot can very easily determine his position. Lines can be drawn on a map through the location of each transmitter parallel to the corresponding pointer and the intersection is the planes location.

The application of the dual automatic direction is very simple. As an example, a pilot can be assumed to be flying a plane from Chicago to Kansas City and to be using the radio stations at those cities to indicate his path. As the plane takes off, one direction finder is tuned to the Chicago station and the other to the Kansas City station. If the plane is on its proper path the two pointers will point diametrically opposite and will be in a straight line as shown in Fig. 1. If the two pointers are not 180 deg. apart the plane is not on its course and it must be swung over until the pointers assume a straight line, or what corresponds to 6 o'clock on a clock face.

The pilot may also choose, sometimes by necessity, two stations off to the side of his course. Then the conditions are as shown in Fig. 2 where the convergence of the angle represents the position of the plane. It is a very simple matter for the pilot to mark off on his route map the lines through each station and determine the intersection.

In addition to the improvements offered in taking cross-bearings in flight and establishing a straight path between any two points, a number of other uses are suggested for this new device. It can supplement, or possibly replace, the present radio beam system. The radio spectrum is already so congested that it may be undesirable to add more beam stations and this is where the dual direction finder may find use in replacing the beam. Another suggested use is to guide planes in for landings, especially after an instrument approach. When the pilot gets the ship in line with the runway and two marker beacons, or one marker beacon and the range station, the two direction finder pointers would both point straight ahead, or be in the 12 o'clock position. As the plane passes over the first marker beacon or the range station, one pointer would swing around and point to the rear of the ship and the indication would be 6 o'clock. As the plane continues and passes over the marker beacon at the end of the runway the other pointer would swing around and the pointers would be in the position of 6·30 o'clock. The plane would then be in a position to make a landing.

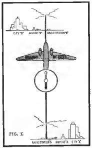


Fig. 1. Diagram of a plane making use of stations at each end of its route for determining its path.

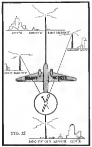
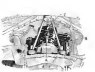


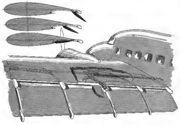
Fig. 2. A plane using two stations off its path to determine its position. The convergence of the angle indicates position.

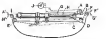
Transmitter-Receiver Weighs Only 10 1/2 Pounds

A transmitter receiver (Type BR3T) capable of transmitting 35 to 50 miles and having receiving range up to 150 miles, yet weighing only 10½ lb., including all accessories, is being produced by Air Associates, Inc., Bendix, N. J. The frequency range of the receiver is 200 to 400 kc. in which are located the radio beacon and weather stations. Shielding on the receiver is such that the airplane and engine need not be shielded. The transmitter operates on 3,105 kc., is crystal controlled, and has a power output of more than 2½ watts. Both the transmitter and receiver are contained in the same case which is 4½ in. wide, 3¾ in. high and 7¾ in. deep. Power for both units is supplied by two 90-volt dry batteries contained in another case of the same dimensions.

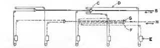


A mechanical starter (above) is one of the new additions to the Luscombe Silvaire Master. It is attached to the rear of the engine at point "A". "B" is the cable attachment to the shock cord supplying the energy and anchored at the tail of the ship. "C" goes through to the instrument panel

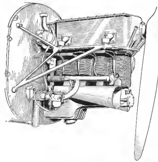




The flap of the Lockheed Lodestar is shown in cutaway at the left and schematically above and at the left below. The hydraulic actuating cylinder (above) operates in the following manner. The flap retraction cable "A" is anchored to the pulley bracket structure at "B" located in the right fuselage wall. Cable "A" travels to and around the forward center pulley of gang "C" attached to the piston shaft, reversing itself to pulley "D". Over this pulley the cable again assumes a leftward direction to pulley "E" to the bracket on the left fuselage wall. From here it travels up and begins its direction out into the wing at "A'". The cable for the opposite wing begins at "F" and emerges at "F'", while the cables "G" and "H", for operating the flap in the opposite direction follow their respective courses. The position of the cables in the wing are shown in the cutaway as well as the various positions of the flap.

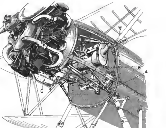


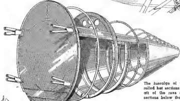
The schematic diagram (above) is a continuation of the paths of the cables at the right, above. Cable "A'" becomes cable "B", while "H'" becomes "H". Moving cable "B" to the right pulls fitting "C", which, through "D" moves the flap attachment fitting "E" downward. On the Lodestar this places the flap in its extended position. Pulling cable "H" to the right closes the flap through "F" and "G".



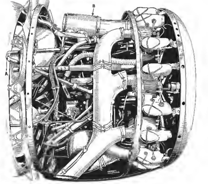
The Skymotor (right) recently developed is shown with its installation in a Piper Cub. Note the 4-point engine suspension and the rather simple engine mount construction. The engine has a 60 B.H.P. rating at 2150 r.p.m. with a displacement of 200 cubic inches. The bore and stroke is 3⅞" x 4¼ respectively. Compression ratio 6.25 to 1, uses a 73 octane gasoline tank, gas consumption .55 lb., or 5.5 gals an hour at full throttle. Overall length is 37" and height 29". It weighs 300 lbs.

The dimensions of the engine mount of the Southern Aircraft BM-10 trainer "A" are: side truss tube 1½ in. by .049 in., top and bottom truss tubes 1 in. by .049 in. The controls at "B" are for the throttle mixture and carburetor air heat. "C" is the carburetor air heat valve. The type of exhaust system used allows for an exhaust outlet from each cylinder to enter a collector ring around the nose.



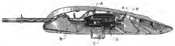


The fuselage of the Meyers Trainer employs rolled hat sections for the bulkheads. The skin aft of the rear cockpit is attached to three sections below the main stringer shown. One piece is on either side of the ship and the third reaches around the bottom.

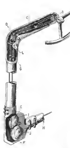


The engine installation in the Vought-Sikorsky VS-310 is designed to be readily removable at "A" and three other points around the fire wall. By disconnecting the engine controls, fuel and oil lines, and quick detachable connections in the electrical and cowl flap control system, the entire power plant may be removed as a unit. The time required for removing one power plant unit and replacing it with another is reduced, with this arrangement, to two hours when using three men. The oil cooler is mounted at "B" on top of the engine.

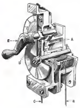
AVIATION'S SKETCH BOOK



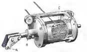
The wing gun cannon installation shown at the left is for a Madsen gun. The letters "A" denote structural members of the wing which take place of main wing spars around the cannon. "B" are gusset plates for supporting the gun and "C" is the loading chute



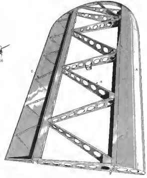
The drawing at the left is the control column of the Lockheed Lodestar. A-control wheel; B-sprocket wheel hub; C-chain; D-sprockets elbow; E-pulley bus cable; F-pulley control cable; G-aileron travel stops; H-torque tube; I-bus cable; J-control cable; K-tab push-pull tube attachment.



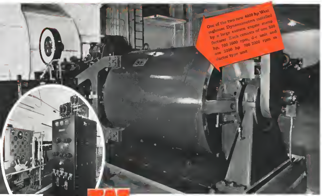
The drawing above is the tab control mechanism of the Lockheed Lodestar: A-Tab drum cable groove; B-Right hand or long cable; C-Left hand or short cable; D-Taper Pin; E-Crank handle.



The drawing above is the tab actuating mechanism of the Lockheed Lodestar: A-Tab push pull tube attachment; B-Tab mechanism housing; C-Tab actuating drum.



The wing structure of the Ercoupe is shown above. The web of the front spar is located at 25% of the chord. This spar is made with aluminum alloy extrusion at the top and bottom which are connected together by a sheet metal web .032" thick. The extrusions taper in thickness along the span of the wing. The nose section "A" has a .0138 sheet of aluminum alloy around the leading edge and is open at the bottom to give access to all rivets. The cross bracing members marked "B" vary in thickness from .15" near the root of the wing to .032" near the tip. These members form the drag bracing, torsional bracing and the form ribs for the part of the wing in which they are placed. The stiffeners on the aileron "C" are ½" x ½" angles made of .25" aluminum alloy.



Front view of machine gun. Letter A indicates gun mount. In center is seen the adjustable screw which raises or lowers the gun

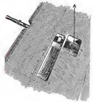
By Loois Bruchiss

and James E. Doogherty, Jr.

Wing Mounting of Aircraft Machine Guns

PILOTS, leaders of the Army and Navy Air Corps, and Project Design Engineers in the various airplane companies all agree that for the modern fighter ship to be an offensive threat it must carry at least six machine guns in its wings. Many of the later designs both in Europe and in the U S have met the problem of installing many guns in such a small ship quite successfully.

Fighter planes that are being designed today will carry two and more 20 mm cannon in addition to numerous machine guns mounted in the nose and wings. To enable this to be done, many innovations in airplane and wing design have been carried out. The details concerning these mountings are confidential and cannot be revealed. However, tens of thousands of pursuit planes still carry only machine guns, and many more still in production will carry this armament only for the time being. It may be of interest to note just how machine gun mounting design is evolved.



The rectangular opening shows the ammunition box with lid removed. Arrow A indicates the charging cable.

We will consider here only those guns mounted in the wings themselves. Fuselage mounted guns are known as fixed guns delivering semi-automatic fire through synchronizing gear attached to the engine, while wing guns deliver fully automatic fire through remote controlled solenoids operating the trigger gear. When operating the wing guns are rigidly fixed in position, although they are sometimes called semi-flexible guns because the actual mounting will permit elevation and depression and a lateral movement of from one to two deg depending upon the wing station where they are mounted. This allows for adjustment on the ground for various combat purposes and insures accuracy of fire after the guns have been installed, tested, and fired.

The 50 cal machine gun we will consider here, has two points for a trunnion and post mounting, through a pintle and trunnion pin or bolt. The method of attachment varies according to the type of wing in which the guns are installed, whether box beam, truss or other form of construction. We are assuming a box beam construction with two main spars—running across the wing. Fighter plane wings are of such dimensions that the 50 cal gun can very readily be attached to both the fore and aft webs of the beam and thus the loads comprising the weight and recoil, and especially the latter, can be carried by the entire beam. At certain wing stations, where very little space is available, due to positioning of the ammunition boxes, or to the necessity of retaining accessibility to gun and ammunition boxes, the gun barrel may protrude from the leading edge of the wing, and the gun itself supported or attached to the web only. In this case, a false beam has to be built between the rib sections on either side of the gun, and the ribs themselves strengthened by stiffeners and similar devices. At other stations, the gun will be mounted far toward the trailing edge and not supported on the beam at all, but the front trunnions will be supported between two special ribs to the rear on a false beam, aft of the rear web.

Preliminary Machine Gun Analysis for Installation in a Wing

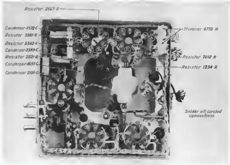
In the assumed wing of box beam construction 50 cal guns are to be placed at stations 120 and 155 along the wing. Gun design loads are:

(1) Vertical load on front trunnion
$P = 435 \times 4 = 1740$ lb
(2) Horizontal load along barrel
P — 435 lb recoil load
$435 \times 4 = 1740$ lb
(The Factor 4, is for safety—also includes impact loads)
(3) The gun weight = 55 lb
This load is multiplied by 13½g factor to meet average design requirements
$P_{gm} = 55 \times 13\frac{1}{2} = 742$ lb

This load is concentrated at the center of gravity of the gun and then distributed to the front and rear fittings as vertical loads. If we examine Fig

(Turn to page 166)

IT ISN'T IN THE BOOK



MASS PRODUCTION
IN AIRCRAFT RADIO

Lear uses a new assembly line technique to turn out its aircraft radio

By J. H. Harris
General Manager, Lear Avia, Inc.

AVIATION radio means eyes, ears and voice to the accelerating stream of aircraft rolling off American production lines today

The solution of our mass production problem differs from the aircraft builder's in one important fashion—he deals in tons of sheet metal and miles of cable; we deal in filaments barely visible to the eye, and in fractional currents detected only by the most sensitive instruments

And our equipment, to merit the pilot's preference, must have the same ability to resist shock and extreme operating conditions as the aircraft in which it is installed

Four years ago, Lear radio equipment was, in the main, custombuilt Each production job had its own specifications Today, with every type of our equipment more versatile, we have the additional problem of engineering each design for mass production


J H Harris

Therein lies our general problem—the production of $5,000,000 worth of sensitive, rugged equipment including receivers, transmitters, navigation instruments, antenna reels and electric motors, all in record time.

The recent acquisition of additional floor space at Piqua, Ohio, offered us the opportunity to institute several unique manufacturing and testing processes developed by us to meet current demands The company already had manufacturing facilities in New York and Los Angeles, with the main plant at Dayton, Ohio

The new Piqua plant, 30 miles north of Dayton, includes three buildings, housing respectively administrative, engineering and manufacturing activities

The first of these buildings accommodates the executive, sales and accounting offices In the second, the work of some 400 machinists, assembly workers, inspectors and testers is carefully planned and correlated from the factory offices The upper floor of this structure is devoted to Lear's engineering department and laboratories Manufacturing activities, in the third unit, are the subject of this article.

Careful plans have been made, keeping in mind the necessity of employing and carefully training approximately 300 employees within the next three or four months Training courses for new employees, covering such subjects as the proper use of tools and good soldering methods, are taught under the supervision of the personnel department Both procurement and education

of new employees is directed by them in close cooperation with the plant management

The new Lear plant was laid out with the thought that raw materials and supplies should come in one end of the block-long plant, and finished equipment should be shipped out of the other end. From the railroad siding and unloading platform on the west end of the building, to the truck loading dock at the east end, materials pass smoothly through receiving, incoming inspection, sheet metal and machine shop, many test and inspection points and so to finished stock

An area of about 2 000 sq ft. is occupied by the company tool room In this room, many of the complex tools, dies and special fixtures required in machining and assembling operations are made by company tool makers A total of $100,000 has been expended to obtain the most modern equipment for the machine shop

Two manufacturing departments are maintained to feed component parts to the assembly benches

The first of these is the coil department. In this division, many of the special coils are wound A great many intricate coil sections are wired so the assembly lines can simply mount them on the chassis and make external wiring connections Some of the more complicated coil assemblies are prealigned before leaving the coil department. This work is done in especially constructed jigs so that an individual section can be worked under operating conditions After being installed in the sets, these sections need only slight adjustments by the final testers

The other manufacturing department is the subassembly department Here as many complete components as possible are made up and then routed to the assembly lines Variable condenser gang assemblies, chassis cables, dynamotor filter assemblies, automatic direction finder control heads, and items of this type are all made in this department. This results in a decided simplification of the work which is done on the final assembly lines

At the assembly lines, material from the machine shop, the sheet metal department, the coil department and the subassembly department converges for final assembly into complete units

For the most part, the assembly workers are women, as they are found to be very adept with small tools and soldering irons

Instead of working from cumbersome sample radio sets, these people work from clear, full scale sequence photographs Each operator has a picture showing just how the set should look after he has finished his work. It shows the operations he performs as well as all those performed by operators preceding him in the line The photographs are marked with part numbers, and other data that the assembly worker must have

This numbering system acts as a means of each operator checking to make sure he has not missed any of his work, as only those parts he is to install, or wires he is to solder, are numbered. The number of photographs of any device was set after carefully studying the number of operations any individual can be expected to perform without making mistakes

To simplify further the complex wiring job, Lear Avia uses a system of pre-fabricated chassis cables These cables for internal wiring are made up on boards into which nails have been driven at every point where a bend is to be made in any of the wires By following a simple diagram, an operator can lay out a complex cable with ease Before removing the cable from the board, all the component wires are securely laced together After removal, the entire assembly is impregnated with wax to make it moistureproof

When these pre fabricated cables are sent to the assembly lines, they can be put in the radio chassis and each individual wire will fall into its correct position. Operators working with their assembly photographs can easily and quickly make the final solder connections.

Inspection and Testing

Throughout the plant are many highly trained machinists and radio men, acting in the capacity of mechanical and electrical inspectors

In a business where failure may not occur, perfect material must be furnished to the assembly lines For this reason, Lear Avia's incoming inspection department checks all purchased materials individually In the machine shop and sheet metal departments, an inspection is made after each operation, spot checking is very rarely resorted to

Throughout the assembly lines, inspections are made at regular intervals as each piece of equipment passes along a line At the end of each line an electrical check, as well as a very complete mechanical inspection, is made Here a set is thoroughly checked for high resistance, solder connections, poor mechanical connections, etc Fixtures are provided for a complete continuity and socket voltage test If any difficulties due to workmanship are found, the equipment is returned to the responsible operator If a defect is due to a faulty part of some sort, it is sent to a special repair department Having passed the line inspectors, the equipment goes to the test department for final electrical tests and aligning

Receiver alignment is performed in a large screen room which accommodates five testers Each tester has the following equipment a high quality Ferris Model 22A signal generator, a General Radio output meter and a Simpson continuity and voltmeter An audio oscillator and oscilloscope is available in this test room for any of the testers who may require these instruments

When testing automatic direction finders, the receiver-antenna portion of the equipment is aligned in this room The test includes proper adjustment of all trimmers, padders and variable resistors, whose settings must be established before the test data can be recorded. The electrical measurements which are conducted for every piece of equipment include I F and R F sensitivity and selectivity, response to undesired signals, such as image ratio and I F rejection, A V C characteristic, and frequency calibration In every instance the accuracy of frequency calibration of all our receiver equipment is maintained to better than ½ of 1 percent

The receiver and gang tester aligns the loop portion of the equipment roughly in order to see that these circuits are functioning No loop or compass data is recorded by the receiver tester.

The equipment is sent into a small one-man compass screen room which is equipped with a transmission line terminated in its characteristic impedance. The room factor of this line is established by mathematical calculation so that the tester always knows the magnitude of the signal into which the loop is immersed

This room is also equipped with a standard Ferris 22A signal generator, a General Radio output meter, a Simpson volt-ohm meter and an RCA oscilloscope

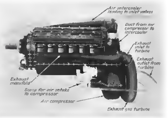
The battery supply in this test room is so arranged that the tester can obtain any desired battery voltage he requires to carry out the tests prescribed on the data sheet which accompanies the equipment This arrangement permits the tester to determine whether the equipment will operate on a very low battery as well as a very high battery This is an added safety factor These battery circuits are thoroughly metered so that the voltage and current demands of the equipment are known to the tester at all times

The loop portion of the equipment is aligned in this room, and the compass activity checked and the data recorded on test sheets which accompany the equipment These compass tests include.

(Turn to page 160)

The Ford V-12 Aircraft Engine

By Paul H. Wilkinson



Side view of mock-up of the new 1,500 to 1,800 hp Ford V-12 aircraft engine. The exhaust-driven supercharger and the intercooler between the cylinder banks indicate that it is intended for high altitudes.

WHEN Henry Ford was offered a contract to build Rolls-Royce Merlin engines in the early part of 1940, undoubtedly he questioned whether these 1,200 hp engines would be powerful enough for first-line fighting planes by the time they came off the production line. Mr. Ford declined the Rolls-Royce contract but his interest in high-powered aircraft engines remained. Shortly after this it was reported from Detroit that he had decided to develop and build a considerably more powerful aircraft engine of his own design.

Development of the Ford V-12 aircraft engine commenced in June 1940. From the start the project was financed by the Ford Motor Company so that it would be free from government interference and red tape. The design decided upon was that of a 12-cylinder liquid-cooled vee-type engine with an output of from 1,500 hp to 1,800 hp at high altitudes. The design specified that the cylinder displacement should be as small as possible so as to keep down weight and overall dimensions. High crankshaft speeds and supercharging were to be resorted to in order to obtain the required power output. Power losses were to be reduced by using an exhaust-driven supercharger while direct fuel injection was to be used to reduce fuel consumption. Last but not least, simplification was to be the keynote so that the engine might be a *real* mass production proposition.

Layouts were started about the middle of July and three months later a 2-cylinder engine was completed and on the stand ready for testing. The test engine was of the same bore and stroke and construction as specified for the 12-cylinder engine so that concise data could be obtained relative to the subsequent performance of the full-size power plant. The results of these tests were most encouraging and showed that the maximum power output required could be obtained at a crankshaft speed of 3,600 r.p.m. The cruising speed of the engine was indicated as being between 3,000 r.p.m. and 3,200 r.p.m.

When the writer visited the Ford Motor Company in Detroit in March, he found many interesting features incorporated in the new engine. A 2-cylinder cut-away working model, parts for a complete 12-cylinder engine and a full-size mock-up showed the thoroughness with which the project was being handled. The engine appeared to be very compact for its intended power output and its parts were rugged and designed for ease of manufacture. A most noticeable feature was the use of centrifugally-cast steel parts wherever possible instead of steel forgings.

The use of centrifugally-cast steel parts is not a new departure at the Ford factory as more than 8,000,000 Ford automobiles have been fitted with cast steel crankshafts during the past few years. Bursting tests conducted with steel cylinder liners have shown that the centrifugally-cast type is more than 50 percent stronger than the forged type due to the greater resistance to fatigue. Another advantage of centrifugally-cast steel parts is that the time required for machining is greatly reduced as very little metal has to be machined off to bring the parts to size.

With regard to the construction of

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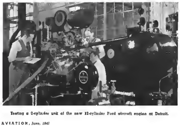


Testing a 2-cylinder unit of the new 12-cylinder Ford aircraft engine at Detroit.

Flying
EQUIPMENT

SOUTHERN AIRCRAFT'S
Basic Trainer

Ease of inspection and maintenance are featured in this biplane

THE Air Corps having increased its rate of pilot training from 12,000 to 30 000 a year with the prospects good for a further increase, military trainers right now are of prime importance

A basic trainer, the Southern Model BM-10 is powered by either a Lycoming, Jacobs or Continental engine of 225 hp With a high speed of 123 m.p.h., a cruising speed of 105, and a landing speed of 50 m.p.h., the ship climbs at the rate of 850 ft per min to a service ceiling of 15,000 ft., and has a normal range of 355 miles Flight characteristics and structural strength conform to requirements specified by the Air Corps for primary trainers

Design of the BM-10 stresses extreme ease of inspection and maintenance, and maximum visibility and ease of egress from the instructor's front seat The fuselage is a welded chrome molybdenum steel tube structure divided into two sections which are bolted together aft of the rear cockpit by means of four taper bolts, the aluminum alloy skin being removable in panels These are hinged at the top and fastened at the bottom by quick-detachable Dzus fasteners In approximately 15 min one mechanic can open up the fuselage completely for inspection of all flight and engine controls Rear section of fuselage is fabric-covered over fairing stringers and section formers rolled from thin aluminum alloy strips. Numerous inspection doors are provided to facilitate inspection and servicing of control system. Cockpits are equipped with adjustable Army type seats and three-piece windshields of non-shatterable glass, together with sponge rubber crash pads for the instrument boards

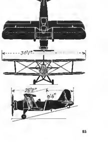
Wing arrangement follows conventional biplane practice of fabric covering on wood framework. The wing assembly consists of a center section, two upper panels and two lower The center section, which supports the single fuel tank, is formed from solid laminated spruce beams, nose ribs, tail ribs and plywood covering A thick sheet of plywood covers the portion between the beams and underneath the fuel tank. The horizontal tail group is offset to the rear of the vertical tail group, thus exposing fin and rudder to free airflow when in a spin Consequently, when the rudder is neutralized after a protracted spin the plane recovers normal flight immediately

The main landing gear consists of two separate units The stub axle, instead of being connected to the lateral strut, as in conventional divided axle type, is attached directly to lower end of the shock absorber strut. The air and oil shock absorber strut and rear brace strut swing as a unit around the hinge axis at the lower longeron

Engine is mounted on eight lugs provided with rubber bushings to dampen vibrations The mount is a conventional chrome-moly steel tube structure attached to main structure by four taper bolts Engine control system consists of push-pull tubes and bell-cranks mounted on ball bearings

Specifications and performance data of the Southern BM-10 are

Wing span (upper wing)	34 ft. 1 in
Overall length	25 ft. 2 in.
Overall height	9 ft 6 in.
Wing area	304 5 sq ft.
Wing loading	9 16 lb /sq ft.
Power loading	12 69 lb /hp
Gross weight	2 790 lb
Weight empty	2 070 lb
Maximum speed	123 m p.h.
Cruising speed	105 m p h
Landing speed	50 m p.h.
Climb	850 ft /min.
Service ceiling	15,000 ft.
Cruising range	355 miles



The Meyers Trainer

A primary and advanced training plane in one unit.

PILOT training now being one of the pressing problems both here and in Canada, where thousands of men from the four corners of the earth are learning to fly to fight Hitler, training planes are at a premium.

The Meyers OTW trainer was designed to fill the need for a training plane that would combine in one unit all the essential requirements for both primary and advanced training At the same time it makes an ideal ship for the private pilot who enjoys open cockpit flying

Powered by a 125 hp Warner Scarab engine, which is standard equipment on the Meyers, maximum speed is 120 m p h. and cruising speed is 105 m p h The ship lands at 40 m p h , climbs 1200 ft. the first minute, has a service ceiling of 17,500 ft , and a cruising range of 400 miles

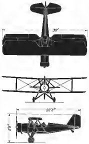
Controllability at low speeds is excellent and all types of acrobatics can be performed with ease Spinning qualities to the right and left are said to be perfect, and even after ten turns recovery is instantaneous upon application of the rudder

Built to withstand the stress and strain of student use the Meyers has an all-metal, riveted fuselage semi-monocoque to the rear cockpit, and full monocoque, 24 ST Alclad, from there aft. Fore and aft cockpits offer exceptional visibility both in the air and on the ground

Wings are of conventional wood and fabric construction with solid spruce spars Tube compression members eliminate the necessity for internal bracing wires Ailerons are the balanced type with Fafnir bearings, and on the lower wings the ailerons are of all-metal alloy construction operated by compression tubes

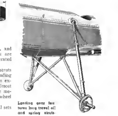
The long travel oil and spring struts of the landing gear are outstanding features of Meyers design, and an exceptionally wide wheel tread of almost eight feet is provided Brakes are mechanically operated, and the tail wheel is a Goodyear full swivel type.

Standard equipment includes dual sets of instruments



Specifications and performance data on the Warner powered Model OTW trainer are

Wing span	30 ft.
Overall length	22 ft. 8 in
Overall height	8 ft. 6 in.
Wing area	262 sq. ft.
Wing loading	6 5 lb per sq ft.
Power loading	14 2 lb./hp
Gross weight	1787 lb.
Weight empty	1207 lb.
Fuel capacity	26 gal
Oil capacity	4 gal
Maximum speed	120 m p.h
Cruising speed	105 m p h
Landing speed	40 m p.h
Climb first minute	1200 ft
Service ceiling	17,500 ft.
Cruising range	400 miles



Landing gear features long travel oil and spring struts

Zodiac Libra-Det

A military trainer type built of plywood to avoid the bottleneck faced by manufacturers of all-metal planes.

A N open two-place low wing monoplane, the Zodiac Libra-Det ZKL-130 has been designed for production to meet present day military trainer requirements without becoming involved in the bottlenecks hampering the construction of all-metal planes

The first production job of the Zodiac Aircraft Corp of Lodi, N J, the "Libra Det" was successfully test flown by Romer Weyant Powered with a 130 hp aircooled Franklin engine, it is constructed entirely of plastic plywood, and has a maximum speed of 122 m p h, cruising at 107 The plane lands at 55 m p h, and climbs at the rate of 825 ft per minute to a service ceiling of 12,250 ft Cruising range is 325 miles with 25 gallon fuel tank capacity

Fuselage is of conventional box type construction with five ply birch bulkheads, corner longerons of 1x1 in spruce, and diagonal braces, against the skin, of ½x1 in spruce Skin is of three ply birch

Construction of the wing consists of box spars with spruce flanges, covered with a ⅛ in plywood skin The outer wing sections taper in thickness and in chord, and are covered with 1/16 in plywood Tail unit is of braced wood structures, built up of spruce and covered with 1/16 in plywood

Consisting of steel tubing faired with wood and fitted with oleo struts, the landing gear is the divided tripod type having low pressure wheels. Tail unit has a 360 degree swivel

A dual control ship, the "Libra-Det" fits into the primary trainer field in which ample demand is expected from increasing American, Canadian and South American programs

Specifications and performance data for the Franklin powered Zodiac trainer are:

Wing span	33 ft.
Overall length	24 6 ft.
Overall height	6.6 ft.
Gross weight	1750 lb
Weight empty	1250 lb
Wing area (with ailerons)	162.5 sq ft.
Ailerons	16.3 sq ft.
Wing loading	10.6 lb./sq ft
Power loading	13 5 lb./hp.
Rudder	7 sq ft.
Fin	3 9 sq ft
Stabilizer	17.2 sq ft.
Elevators	14 sq ft
Maximum speed	122 m p h
Cruising speed	107 m p.h.
Landing speed	55 m p h.
Climb	825 ft./min
Service ceiling	12,250 ft.
Cruising range	325 miles

"I SMILED when the Chief Engineer handed me his notes at the end of the conference with the Production Chiefs When he said, 'Bill, have your draftsmen make these changes . . . corrected drawings must be ready in two weeks,' I knew I would give him and the rest of the boys a big surprise.

"For years we've had the same problem of rushing out drawings on new models Last minute changes demanded by the production department always proved a Jonah . . . disrupted the whole drafting department for weeks.

"But I knew it was going to be different this time Now, with an Ozalid machine installed right in the drafting room, we were all set to make changes in a hurry.

"What a time-saver for a drafting department, I thought, as I realized we were going to cut our drafting time from weeks to days. Here's how we did it

"We made Ozalid transparent duplicates of all drawings to be revised . . . deleted that part of the design to be changed with Ozalid Corrector Fluid . . . drew in corrected details and specifications in pencil *Result* . . . altered transparent prints which actually are new originals . . . prepared in a fraction of the time required to make the same changes by the Van Dyke Process or by retracing

"But how do you like this—when I handed the complete job to the Chief Engineer 10 days ahead of schedule, he never batted an eye. I couldn't understand it, and it wasn't until later that I found out he knew about the Ozalid Process all along and had told one of the boys to put me wise to the savings possible with an Ozalid installation. Was my face red!

"Let me give you Chief Draftsmen some sound advice: Don't make the same mistake I did Don't wait until the Boss gives you a hint before you investigate the short cuts in drafting possible with Ozalid transparent duplicates. Don't delay. Get the facts today"

SPECIFY Ozalid WHITEPRINTS

OZALID PRODUCTS DIVISION
GENERAL ANILINE & FILM CORPORATION
JOHNSON CITY, N. Y.

Ozalid in Canada • HUGHES OWENS CO LTD., Montreal

Advantages of OZALID TRANSPARENT DUPLICATES OVER VAN DYKE NEGATIVES

OZALID	VAN DYKE
Ozalid transparent duplicates save retracing and are made in 2 easy steps with standard equipment in the same simple manner as Ozalid whiteprints	Van Dyke negatives are made in 5 steps by a method that requires much space and is complicated by the use of running water, special trays, printing frames and drying areas
Any part of the detail on an Ozalid transparent duplicate can be deleted with Ozalid Corrector Fluid. Changes or additions can be made on the same print with either pencil or ink taking only one quarter to one third the time required to make similar changes by the Van Dyke method	Changing a Van Dyke negative is a complicated process requiring opaque, paint brush and a corrector fluid which is often unsatisfactory Practical results are usually secured only when the changes are "blocked out" on the Van Dyke negative and another positive Van Dyke or photo cloth copy is made and reworked
Ozalid transparent duplicates are true to scale and are permanent They do not deteriorate with age	Van Dyke negatives are subject to distortion and unless properly dried often become brittle

The speed when printing from an Ozalid transparent duplicate is 3 to 5 times faster than the printing speed possible with a Van Dyke negative

Aviation's Earning Power

By Selig Altschul

"ALL that glitters is not gold" is a maxim that applies with particular force to the air lines at the present time. Hardly a day passes without a newspaper report of some air line recording important gains in revenue passenger miles or in gross revenues. Unfortunately there is "many a slip betwixt gross and net". This makes it almost mandatory not to stop at fragmentary news reports but to reserve judgment until all the results are in. For example, passenger revenues for American Airlines in the first quarter of 1941 amounted to $3,510,847—a record for the period, and a gain of 28 percent over the 1940 quarter. Yet, net profit for the period was down from $304,053 to $71,060—a decline of 76 percent. More gross and less net—a strange anomaly in a growing industry. This result however, merely reflects the increased costs incident to new equipment acquisitions and training expenses for new personnel. Not only are well-trained mechanics lured to better paying jobs in the aircraft industry but there is no longer available a reservoir, from which the air lines may draw upon for new men. Moreover, replacements must be made for many employees drafted under the Selective Service Act. It can thus be seen that not all training expenditures can be attributed to pilots and new plane acquisitions.

American's increase of almost 50 percent in its provision for obsolescence and depreciation also helped offset traffic gains by a substantial margin. Interestingly enough, the provision for depreciation was revised downward effective Jan. 1, 1941, on aircraft radio equipment and propellers, and accounted for a change of $32,192 less than it would have been had the previous rates been continued. In other words, without this depreciation rate revision, American's first quarter net profit would have been further reduced from $71,060 to $38,868. It is fair to note earnings for the 1940 March quarter were bolstered to the extent of $110,025, representing a non-recurring profit on the sale of aircraft.

It is important to segregate these non-recurring profit items in order to obtain a true picture of earning power of any company in any industry. *The main pursuit of an air line is to sell transportation* in all of its branches—passenger, mail and express. *The sale of airports and planes is not one of the major objectives* of a transport company. Yet a substantial portion of the air transport industry's 1940 net income resulted from other than "normal" operations. Of the industry's 1940 net income of about $4,400,000 more than 25 percent came from non-recurring sources. Among the major units, non-operating profits ranged from a high of 41 percent of United's net income to a comparable figure and low of 14 percent for American. For 1941 it is unlikely the industry will show any substantial non-recurring income.

The detailed analysis surrounding American's report for the first quarter of 1941 may also be applied to the statements currently being released by other carriers.

Due to their highly seasonal characteristics, Eastern and National may be the only lines to join American in the profit column for the current March quarter. Indications are that all of the other carriers finished the first three months with material deficits. Such losses may be attributed, for the most part, to the factors already enumerated.

It is significant that a large percentage of these increased costs, which accounted for reduced profits or larger deficits, may also be classified as non-recurring and may not forever be present to plague the air lines.

Non-recurring or otherwise, investors have expressed their disappointment in air transport securities with the consequent effect of these issues selling into new low ground. As indicated by our averages, the air transport group on May 2, 1941, (at 00.00) reached a new low since Dec. 1, 1939—virtually canceling the outstanding rise experienced last year. The all-time peak was attained on Apr. 12, 1940, with the air transport average at 34.66. As a contrasting note, the aircraft average recorded its high of 48.65 on Nov. 3, 1939—the same day the general market, as expressed by the 50 stock average, made its high of 93. The aircraft group, however, at its recent low of 32.68 on Apr. 17, 1941, was at the lowest level since Sept. 1, 1939, when we first started to use the accompanying averages. On the other hand the air transport group remains above the low of 14.38 recorded on Sept. 1, 1939. In addition to depicting the *trend* of aviation securities as against the general market, our averages may also have application for those who are "chart conscious" and who desire to interpret technical market movements as a basis for commitments.

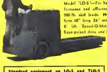
The approach of the normally profitable summer season held considerable promise for the air transport industry to show sufficient earning power to more than offset the losses sustained thus far this year. Then came the announcement that the President had directed Secretary of Commerce Jones to make a survey of transport air lines to see how many planes could be bought for lease-lending abroad. It was indicated that a substantial number might be available but there was no thought of limiting production of civil airplanes at this time. This news obviously implied near-term restriction of air carrier operations with its consequent limitation on earnings. Once again the reaction in the market-place was lower prices for air transport equities.

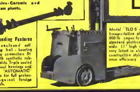
Overlooked by many was the fact that the air lines for almost a year have been selling their older type planes to the British. Such sales have been made as more modern planes were acquired. As previously indicated, it is precisely these sales which accounted for an important segment of the industry's 1940 net income. Informed sources feel that only a small amount of surplus equipment is currently available. Moreover, press dispatches report the President as indicating that no curtailment of domestic air service was envisaged. All that may be anticipated, according to observers, is the restriction of further expansion in the form of opening up new routes. Estimates indicate that even after the sale of available "surplus" planes, the air lines would still be able to handle the anticipated 25 to 30 percent gain in traffic this year.

The new tax bill to be enacted may be expected to take its toll of any residual air line earnings. While under existing legislation, the air carriers are exempt from the imposts of excess profits taxation, there is no assurance that such exemption will be maintained. The industry can, however, count on the normal tax rate of 24 percent being increased to 30 percent.

All these factors conspire to becloud the immediate outlook for the air transport industry. Possible interference with normal operations by government edict is nowhere as high-lighted as it is in the air transport industry. This condition will undoubtedly lead to considerable nervousness on the part of air carrier investors who may be inclined to overlook that no one single company or industry is immune from increasing government restrictions.

(Turn to page 146)





BUYER'S LOG BOOK

What's New in Accessories, Materials, Supplies, and Equipment

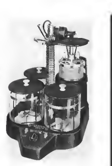
Said to solve the old problem of proper instrument cleaning, the *L & R Instrument Cleaning Machine* and "Power Nofome" cleaning solution will effectively clean instruments, parts and assemblies in between 8 and 12 minutes Developed by *L & R Mfg Co*, Newark, N J, each machine is furnished with 1 gal of Power Nofome and 2 gal of rinsing solution Basket holding work readily snaps into place on the motor shaft, and the central bar, on which agitator motor is mounted, properly positions basket over each solution jar The basket is first lowered into jar containing Power Nofome A rheostat regulates motor speed, the motor driving the basket through a 14 to 1 reduction gear After running in solution, motor carrier is raised out and rotated to throw off excess solution Operations are repeated in second and third jars containing rinsing solution Fourth position is the drying chamber which contains a separate motor and fan in conjunction with a hot plate. Net weight of machine without solutions is 41½ lb; dimensions 17½ × 16½ × 23 in; jars of 1½ capacity—AVIATION, *June 1941*

For lubricating unreachable parts, *Wilbur & Williams Co* 348 W 42nd St., New York, N Y, have a penetrating oil that should go a long way toward making the wheels of National Defense turn more smoothly Here is an oil that will prevent delicate steel parts from being rendered useless with slight tarnish or rust marks resulting from perspiration from operators' hands Flowing freely at temperatures as low as 40 deg F below zero, this penetrating oil will not become gummy or sticky at 1000 deg F, but remains greasy without carbonizing into hard particles—AVIATION, *June, 1941*

A new development, the Automatic Microsize Control Unit, will be of first interest to all production personnel responsible for the final finish processing of bores Released by *Micromatic Hone Corp*, Detroit, Mich, the Control Unit generates accurate sizing—in high production—uniformly within the limits from .0002 in to .0005 in, reducing the tolerance range and number of selective fits Mechanism is arranged with visual dials to facilitate set up adjustment and complete operating control. Additional controls provide for (1) instantaneous abrasive expansion only to average rough bore size (2) controlled uniform rate of abrasive expansion feedout to uniform size and finish, under variable pressure, and, (3) expansion collapse of abrasive members always to same starting diameter, under mechanical control, and automatic compensation for average stone wear—AVIATION, *June, 1941*

A compact single purpose collet chuck, which can be attached quickly to handpieces used on Stow flexible shaft machines, has just been brought out by *Stow Mfg Co*, Binghamton, N Y New unit is furnished in two sizes ¼ in and ⅜ in chucking capacities and in two styles With straight threaded hexhead stud, the collet chuck interchanges with the clamp spindle on standard handpiece With the tapered shank it fits into the tapered socket of the high speed hand-piece, a type used with rotary files, mounted points or other high speed tools, to assure true running on precision work Tapered type of collet chuck will also fit a tool post attachment for grinding operations with a lathe—AVIATION, *June, 1941*

A versatile precision tapping machine is a practical tool, and *Bakewell Mfg Co*, Los Angeles, Calif, in their Precision Tapper have a tool which will give a perfect thread in plastics, aluminum and its alloys, magnesium, bronze, die casting, nickel and stainless steels, and chrome molybdenum alloys It will cut internal and external threads with equal ease, right or left hand In the No 2 Tapper, built for heavier work than the No 1, the 2 hp motor has two forward speeds 900 and 1800 r p m, and a reversing speed of 1800 r p m It is also back geared integral with the motor, and in addition has a back gear located in the head of the tapper giving a speed range of from 12 4 to 1442 2 r p m With a Bakewell, tap breakage is no longer a consideration A clutch, adjustable to the safe torque resistance of the tap will slip before the tap breaks—AVIATION, *June, 1941*


L & R Instrument Cleaning Machine


Micromatic Control Unit


Bakewell Precision Tapper

Peters "Fitzem" Screw Driver

Progressive 3-Phase A C Welder

Yale & Towne "Red Streak" Truck

Firestone Rayon Tire

The "Fitzem" screw driver, a recent development by *Peters Mfg Co* Cleveland, Ohio, is claimed to be the only screw driver which can be used on both Philips recessed-head and slotted-head screws Blade is reversible and interchangeable, made of molybdenum high carbon steel, heat treated and Rockwell tested Handle is extruded plastic, unbreakable, non-chipping, non-splitting and shock proof, and unaffected by oil, water or grease Available in sizes No 1 to 4 in various blade lengths, it gives universal coverage and is guaranteed for a lifetime. Sold by The Servwell Products Co, Cleveland, Ohio —AVIATION, *June, 1941*

High speed production process for spot welding aluminum may prove a simple solution contributing to mass production of aircraft Announced by Progressive Welder Co, Detroit, Mich, the new process involves no costly "energy accumulators." Principle on which equipment operates is based on use of all three phases of 3-phase alternating current and consists essentially of passing current through a converter, which eliminates negative portions of wave Resulting pulsating current has time cycle of 300 deg instead of 360 deg Current then passes through welding transformer amplifying current This secondary wave, ideal for welding aluminum, rises to maximum almost instantly Complete equipment is almost identical with standard Progressive pedestal type welding equipment—AVIATION, *June, 1941*

Bringing Archimedes' principle of the lever and fulcrum up to date, *Yale & Towne Mfg Co*, Philadelphia, Pa, announce the new and improved "Red Streak" hand lift truck with simplified lift redesigned for utmost efficiency The "Red Streak" lift mechanism has fewer moving parts and incorporates safety features to prevent tripping and "flying handle" Entirely new is the handle balancing mechanism which keeps handle in upright position, prevents tripping and relieves operator of handle weight Less bending effort is required because of a shorter handle stroke, and to prevent "cornering" in cramped quarters, the truck features 90 deg lift and full 180 deg steer Improved "Red Streak" is available in wide or narrow frame models—AVIATION, *June, 1941*

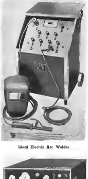
Contributing to more economical operation of transport planes, *The Firestone Tire & Rubber Co*, Akron, Ohio, has introduced a new rayon airplane tire 14 lb lighter than the conventional tires used In actual plunge tests the new tire (size 7.00-16, 10 ply) withstands 38 percent more punishment than old style tires, and tests simulating landings showed rayon cord body is 100 percent more durable Tread features a 10-rib design and is made of a new rubber compound which bonds inseparably with the cord body Importance of weight reduction is apparent when evaluated in terms of additional payload It has been estimated each additional pound of payload brings in an extra $30 yearly—AVIATION, *June, 1941*

Changeover to plastics in aircraft parts manufacture will be facilitated by H P-M Injection Molding Presses designed and built by the *Hydraulic Press Mfg Co* Gilead, Ohio Operating on injection process, rather than compression method H-P-M presses are said to result in high production through increased speed of press operation. Basic specifications clamp pressure, 200 tons, max mold size 16½x24 in, min shut height of mold, 6 in, max opening between plates (open), 18 in, max stroke of mold carrier platen, 12 in., max. weight material injected (one cycle), 12 oz, pressure p s i on material in injection chamber, 30,000 lb—AVIATION *June 1941*

HPM Injection Molding Press

POrete Roof Decks

Roof decks for aircraft factories, having a great strength plus light weight, which are of fire and fungi proof construction, and having excellent sound absorbent qualities, are a product of *POrete Mfg Co*, North Arlington, N J. POrex Slabs are made of high grade mineralized wood fibre bound under high pressure with Portland Cement. These slabs will stand up under continuous exposure to water, are odorless, and will resist a fire of 1700 deg F for over an hour. Tests show plain POrex Slabs without finish are good for a breaking load of over 325 lb per sq ft. on a 25 in spacing of the purlins, even after 40 hrs. of immersion in water.—AVIATION, *June, 1941*



Ideal Electric Arc Welder

Simplified welding is claimed as the outstanding feature of a new a c electric arc "Weldmaster" just announced by the *Ideal Commutator Dresser Co*, 5146 Park Ave, Sycamore, Ill. Design includes a reactance winding on a separate core in addition to transformer. Winding acts as a stabilizer, making it easy to strike an arc and hold it. Standard welder is for 230 volt, 60 cycle operation. Overall dimensions, 17x15x26 in, weight 190 lb. Fifteen different welding heats between 20 and 175 amperes give the operator accurate heat and penetration control for each individual job and different parts of same job. Penetration may be up to ½ in or more if desired.—AVIATION, *June, 1941*

Air Assoc. Prop Governor Test Unit

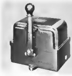
A new bench unit for testing propeller governors has been developed by *Air Associates, Inc*, Bendix, N J. Compact, easily operated, unit is designed for all types of existing governors and has sufficient oil flow to test larger types now being developed for new propellers. All required indicating devices are provided to give a thorough check of governor operation under all service conditions, and to permit accurate adjustment of unit for optimum performance. Mounting pad with adapters for various types of governors, an electric motor with variable speed drive, tachometer, pressure gages, and a specially designed flowmeter are included with the bench unit. This flowmeter indicates oil flow in quarts per minute with an accuracy of two tenths of one percent. Complicated weight tanks and oil collector devices are thereby made unnecessary.—AVIATION, *June, 1941*

Walker-Turner Flex. Shaft Machine

Flexible shaft machines for grinding, burring, lapping and polishing internal and external reduction gear teeth should be of special interest to the growing crop of aircraft engine manufacturers. These machines, which are standard equipment in some of the big engine plants, are made by *Walker-Turner Co, Inc*, Plainfield, N. J., in various models. Two-speed bench bodel with ½ hp geared motor has a low speed of 1750 and a high speed of 3500 r p m. With a stepped-up gearing this gives a spindle speed of 3800 and 7600 r p m respectively. Shaft is built of highest quality high carbon steel, extremely flexible yet unusually rugged. Other models by Walker-Turner may be had for grinding and burring of cylinder heads, finishing oil sump castings and small parts, finished polishing of crankshafts, etc.—AVIATION, *June, 1941*

Type D Mu-Switch

Demand for a millibreak switch for d c. service can be satisfied by the new type D, Mu-Switch, developed by *Mu-Switch Corp*, Canton, Mass. Capable of handling non-inductive loads of more than 2 kw, this latest development gives designers means of simplifying d c. control circuits by elimination of relays. Particularly interesting, its special alloy contacts and magnetic arc blow-out device obviate need for the condenser, heretofore considered an essential adjunct to a contactor breaking d c loads. Guaranteed for a million operations at full rated load—AVIATION, *June, 1941*


Cutler-Hammer Controller

Speed up of production is the result claimed for the new line of cam operated mill duty controllers made by *Cutler-Hammer, Inc.*, Milwaukee, Wis. Available in two-speed, three-speed, and multi-speed types, the controllers are ideal for mill auxiliaries, crane hoist, bridge, and trolley applications. Contacts are verticle, double break, silver to silver; cam shaft operates on ball bearings sealed against dust. Easily accessible terminal board simplifies installation and service, and a heavy case and cover, for either separate or bench board mounting, provide protection from dust and mechanical injury—AVIATION, *June, 1941*.


Dumore Explosion-Proof Motor

New explosion proof aircraft motor for propeller and carburetor de-icer pumps, and other applications in the industry, is produced by *The Dumore Co.*, Racine, Wis. Having a 1/30 hp. rating at 7500 rpm. and built for continuous duty, 12 or 24 volt operation, the new type "E2X" motor meets requirements of U. S. Air Corps specifications 32159 and 32160 Class C, style 1V. It is outstanding for its compact construction, having an overall length of 4½ in. and weighing 2 lb. 2 oz. Another motor, larger and developing more power, but of the same series, is the A2X with a rating of 1/15 hp.—AVIATION, *June, 1941*.

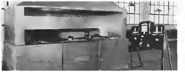

Freedman-Burnham Adj. Pitch Prop

Wooden adjustable pitch propellers for light aircraft should interest pilots who have experienced difficulty in take-off and climb in the higher, rarified atmosphere of mountain fields. *Freedman-Burnham Engineering Corp.*, Cincinnati, Ohio, claim their propeller can be adjusted to prevailing conditions and guarantee sea level take-off performances from fields located at altitudes up to 10,000 ft. Smoother running engines are obtained with the F-B propeller, and when correct pitch is set, it is possible to effect a saving up to 10 percent of gas and oil. At sea level, again by adjustment to local conditions, it is possible to get from 50 to 150 ft. per min. additional climb, and from 3 to 6 miles per hr. faster cruising speed than with a fixed pitch prop.—AVIATION, *June, 1941*.

For mass production, the Scherr Comparitol provides an easy, fast and dependable means for inspection of finished parts, gages and tools. Inspection is said to be cut in half by this instrument which checks as close as .0001 in. Made by *George Scherr Co.*, Inc., New York, N. Y., the Comparitol permits operator to use both hands for handling work and provides practically foolproof visual operation. Any operator, skilled or unskilled, can easily read and understand the plainly defined scale. Parts can be inspected as fast as an operator can pick them up and push them under the feeler point. Weighing only 25 lb., the instrument is readily portable and will give years of trouble-free service in continuous shop use.—AVIATION, *June, 1941*.


Scherr Comparitol

An internally heated electric salt bath furnace, said to produce more uniform heat, reduce fuel costs and eliminate excessive spoilage of carburizing salts, has been brought out in an improved type by *Upton Electric Furnace Co.*, 2211 Grand River, Detroit, Mich. Featuring the adoption of a ceramic brick pot guaranteed for one year's operation, the new model is based on a design described as the "electrothermic—permeation" principle. Heat for the bath is generated throughout all the effective working space, and distribution of current flow for heating the salt is by unique arrangement of electrodes so that greatest heat is at bottom of the pot, with the balance decreasing in intensity as it approaches surface of liquid. Overheating of work does not occur because of great difference between the electrical resistance of any metallic part and the electrical resistance of salt.—AVIATION, *June, 1941*.


Upton Electric Salt Bath Furnace

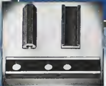
ADEL — A NAME THAT ALWAYS STANDS FOR *ACTION*

JUST AS THE BOMBER'S CREW depends on the split second action of Adel Hydraulic Selector Valves, so major aircraft companies of this country have learned to count on Adel for *action* in design and production, not only of hydraulic equipment but also of a score of other vital proprietaries. Whether the demand be for increased production of products already standardized, or for new accessories to cope with new problems, America can always look to Adel for *action.*

1. *4 way 5 GPM Durel Seat Improved Design Valve, for bomb doors, wheel doors, landing gear, landing flaps.*
2. *New 4 way Hydraulic Control Valve for cowl flaps and oil cooler doors*
3. *4 way Hydraulic Control Valve — special type for gun charger controls.*
4. *4 way 5 GPM Durel Seat Triple Unit Selector Valve for landing gear, cowl flaps, wing flaps*

ANSWER TO ANTI-ICING PROBLEMS—Adel Series J Direct Drive Vane Type Anti Icing Pump for propeller and carburetor protection. Weight—2.60 lb. Capacities from 5 to 15 GPM

ONLY [illegible] [illegible] Commercial Airlines approved Adel Clips as the only [illegible] cushioned [illegible] for [illegible] without supplementary bonding means. More than twenty five million now in service throughout the world. Today's defense production exceeding two million per month!



BLOCKS, STRIPS, PADS—Adel Dual Purpose Line Supports available in 1400 types to support 1 to 30 lines. Cowl Strips and tank pads made of patented "Adelite" lighter and more resistant than ordinary synthetic rubber.

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THE AVIATION NEWS

BLAINE STUBBLEFIELD, Washington
C. F. McReynolds, Pacific Coast
Jay P. AuWerter, New York
E. R. Lockin, New York
JUNE 1941

Auto Share in Plane Program Stepped Up To Get More Bombers in '42

Washington (AVIATION Bureau): The huge new fleets of bombers with which Roosevelt made headlines are to be built in cooperation with the auto industry. FDR revealed a plan, in formulation for several months now, to step up Knudsen's Detroit bomber program of last fall. But the new bombers won't be in production, probably, until about July of 1942. The present Detroit program calls for production, starting late this year, of 100 four-engine bombers and 200 twin-engine bombers a month. The new plan, when it gets rolling, would step up this output with the result that there would be a substantial increase in the proportion of four-engine equipment.

First step in the new program, according to present plans, will be provision of more assembly capacity. However, the whole program is to be pushed forward as fast as possible.

For the past year the idea has been kicking around that the auto industry should build aircraft. The first large-scale move in that direction came last fall when Knudsen announced his plan to have auto firms build parts and subassemblies to be assembled in four midwestern government-owned assembly plants. This plan greatly increased the previously scheduled productive capacity, as of July, '42, for medium and heavy bombers.

Details of the newest program are still secret, but apparently it is intended to take the final step, and assign the job of building complete aircraft to Detroit. In part, the present system will be followed.

To expedite construction of the four government-owned assembly plants, W. H. Rose, consulting engineer, has been placed in charge. Rose will work under Office of Chief of Engineers, which has charge of general AC construction program.

But at least one or two auto firms may build complete planes. Ford has been anxious to take on this job, and, although the Air Corps discouraged him, has designed his new parts plant so that it could be adapted to final assembly. And there is talk that General Motors, and perhaps others, may try their hands. Substantial capacity for this job should be released by the curtailment of auto output.

MOST SIGNIFICANT AIRLINE SAFETY AWARD ever made went to American Airlines for having flown a billion passenger miles over a five-year period without a fatality. The National Safety Council gave the trophy to President C. R. Smith who accepted it in the name of American employees. This group received the award for the employees: l. to r.: W. S. Fletcher, agent; Fred Wright, chief radio operator; W. R. Vine, chief pilot; A. F. Duffey, first officer; G. N. Theban, fleet service; Dorothy Murphy, stewardess; Tom Stone, mechanic.

IGOR SIKORSKY made news again at Stratford, Conn., when he flew his helicopter for 92 min. 26.1 sec., which is a new world's record. The helicopter was then put on these rubber floats and Mr. Sikorsky took off and landed on the Housatonic River, believed to be the only amphibian flight of a direct-lift aircraft. (See story, page 114.)

NEWEST REPUBLIC is the Thunderbolt. This XP-47B has a P & W 2,000 hp. engine which will carry it to great heights at tremendous speeds. The ship is said to have terrific fire power.

Hamilton Wright Miami

NAVAL CHIEFS of eleven Latin American republics now touring the U. S., make their first stop at Miami to visit the Naval Air Station. In New York they visited Wright Aeronautical and will visit major plants throughout the country.

CPT Trainees Volunteer Rate, 100 per Week Army, Navy, Now Have Drawn 5531 Graduates

Washington (AVIATION Bureau) — CAA Civilian Pilot trainees now are volunteering for the Army and Navy air services at the rate of well over 100 per week, says Donald H. Connolly, Administrator of Civil Aeronautics. About one-fifth of all cadets entering the Air Corps in March, and more than one fourth of all the nominees accepted for Naval training during April, were CAA pilot trainees.

Out of the March Air Corps class of 2062 cadets, 459, or 22 percent, were graduates of the CPT. The Navy figure (for April) was 260 CPT trainees out of a total of 940, approximately 27 percent.

"Each time we get a new set of statistics they bear out our often repeated statement that we are providing an economic backlog of pilot material from which the services can obtain large numbers of 'air-wise' young men," said General Connolly "The number joining the Air Corps in March, for example, is 23 percent larger than the number in February

"The majority are college students between the ages of 19 and 29 and as a matter of national policy are not subject to the draft rulings. However, the fact that they are volunteering in increasingly large numbers all the time seems to me to answer those persons who questioned the patriotism of our young men when the pledge of service was inserted last summer in the application for pilot training"

To date Army schools have drawn 3,728 graduates of the CAA training and the Navy 1,903, according to official service records

These figures include only those students who are now in military training or have been definitely accepted and are waiting orders

Scholastic credit for completion of the Civil Aeronautics Administration's CPT work is being offered by 362 colleges and universities This is more than one third of the total number of schools participating in the program There are 645 college and 203 non-college training centers participating at present.

Discussion about curtailment of CPT, or transfer to the Army, had ceased at this writing Apparently an agreement had been reached between the Services and Civil Aeronautics as to the value of the training for defense.

Sihorsky's Humming Bird

Igor I Sikorsky has established a record of one hour, 32 minutes, and 25 seconds for helicopters in his "VS-300" direct-lift machine, on which he has conducted experiments for the past two years The run was officially timed by NAA's Contest Board The Germans set the previous record of one hour 20 minutes and 49 seconds, in 1937 There is no other helicopter on this side of the globe and few in the world. Sikorsky's machine is the first to fly successfully with a single main rotor, the Germans used two

A 90 hp air-cooled engine turns the rotor, which has three 14-foot controlled-pitch blades Climb, descent, or suspension are achieved by shifting the pitch of the blades and varying the throttle Lateral movement results from tilting the axis of the rotor in the direction desired forward, sidewise, or backward. If the power plant, or connecting drive, should fail, the craft autogiros down

Mr Sikorsky, who built helicopters in his native Russia, says control, the most difficult problem, has been 100 percent solved in this design This development will be followed with interest by the aviation world, because of the obvious advantages of such a machine for civil and military use

$61,000,000 for Ports

Although CAA appropriations as they passed the House provided only enough money to complete the original 250-airport development program, $81,477,750 is being added at the President's request to include improvement of 149 additional public landing areas and further improve 20 others already under development

The Budget Bureau officially approved the request "because of the increase in the number of tactical units of the Air Corps and in the number of advanced training schools under the 30,000-pilot program," indicating that the Army may avalanche onto a far greater number of commercial fields than it is now using

Meanwhile, WPA announced a $150,000,000 350-airport improvement program which may reach a 400 total by next July Over the past five years, WPA has worked on 750 airports, building 200 new ones and 400 miles of new runways

Under a new bill sponsored by Senator McCarran (D, Nev), existing law would be changed allowing the government to lease public lands for airport use in lots of 2560 acres instead of only 640 acres as at present

THE BELLANCA YO-50, a slow-moving liaison observation plane, now being flight tested by the Air Corps at Newcastle, Del

Gravelly Point Opening Planned for Early June

Slowness in building construction was responsible for the delay in completing the Washington National Airport at Gravelly Point, now scheduled to open around June first Already some 300 airplanes have landed on the new field

Quarters will be provided at the field for the airport management and for CAA traffic control divisions for the area Lacking a CAA administration building at the site, as earlier planned, a large bulk of CAA offices will take over nearby laboratories originally built for the Bureau of Public Roads, which will construct a new office for itself

Meanwhile, the fate of old Hoover Field has not been definitely decided although the owners are hoping the War Department will buy it as an extension to adjacent land where Army cantonments are going up. Congress has already provided authorization for the purchase but has not handed out any money Bad luck finally caught up with the airport on which accidents, because of obstructions and short runways, were always predicted but never happened—in its closing days a Bolivian good-will flyer was killed, but the crash was off the field after take-off

As Gravelly Point opens, reports are rising that the Army will move in sooner or later

Coast-Geodetic Survey Produces Air Charts

U. S. Coast Geodetic Survey during the past 10 months has filled orders for 999,192 aeronautical charts, compared with a total of 463,917 during the entire fiscal year 1940, according to an announcement by the Department of Commerce Charts are used for training pilots, and in military and civilian aviation

The flight check of an average chart requires from 50 to 90 flying hours, covering 50,000 square miles Every item visible from the air and appearing on the chart is carefully checked

Long-distance flying called for a series of special aeronautical charts prepared by the Survey on a scale of about 16 miles to the inch The Survey also prepared a series of radio direction finding charts, especially designed for use in air navigation, which are on a scale of about 32 miles to the inch

For some time past the Survey has been engaged in the preparation of a series of aeronautical charts of Alaska for both military and civilian use Similar work is being done in other American possessions

Practice Forced Landings Net 41 Accidents in '40

During the calendar year 1940, 41 aircraft accidents occurred while simulated forced landings were being made Of these 41 accidents, all but two occurred in the course of dual instruction; therefore, no differentiation is made between dual and solo flights. The records indicate that practically every accident was the result of pilot error or engine failure and involved stalling the plane, undershooting, overshooting, or striking obstructions.

LA Port Expands

Voters of the city of Los Angeles approved a $3 500,000 airport bond issue on May 6th by the required two-thirds majority, first time since depression days that such a bond issue has been carried there. As a result work will start immediately on expansion of the field and facilities to accommodate all airlines operating into Los Angeles A new administration building to cost $1,000,000 will be erected on the north side of the field, shops and hangars will be built by the airlines Addition of 320 acres of land will bring the airport to 960 acres, and potential length of east-west runways to more than 7,000 ft Total investment in the completed airport, including city, Federal, and private funds is about $10,000 000

SPOT CHECKING

Republic Aviation's 2700 employees waived their summer vacations to speed production and it was expected other groups would follow the example.

One and one-half billion dollar RFC bill to broaden lending powers, includes money and authority to buy Axis air interests out of South America seemed headed for quick passage as this was written

Training of 3000 RAF pilots in the U.S has been arranged, big group expected next winter Also increase of air students from Latin America seems probable

Air Associates, Inc, announced purchase of the former Fokker airplane plant as part of an expansion program The company said it was planning to build an addition which, with the Fokker facilities, would double its present floor space of 69,000 square feet.

Army's anti-aircraft strength has been more than tripled in the past year and National Guard AA regiments more than doubled Firing at targets is going on in 10 cities

Drafting of aviators and trainees for ordinary military duty finally came to the attention of Congress

Lightest armament of any standard U S fighter plane is 4 machine guns, most carry six to eight, some carry 20 mm or 37 mm cannon, effective range one mile, says Aero Chamber of Commerce

Time payment plan for airline travelers regarded by some observers as fine idea but likely to oversell space available as military officers and defense officials take priority on seats.

Republic Aviation announces election of John Hanes, former undersecretary of the U S Treasury, to its board of directors

Thirty instrument landing stations are provided for in funds allocated by CAA Some stations are already in commercial use, and Army is practicing on them Line of lights extended from runway may help pilots in zero-zero landings

First 20 mm cannon for mounting on airplanes has been delivered to the Army, made by Bendix

Pay for parachuters, extra $100 for officers and $50 for enlisted men, passed by Congress.

Bolivia expropriated its German-dominated Lloyd Aereo Boliviano airline, which held an exclusive franchise, a significant move in connection with U S policy of eliminating Axis air interests in S A

Annual Aircraft Export conference (Aero Chamber) this year had nothing to export, since the U S, under Lend-Lease authority, buys all U S production There was much talk about expected post-war trouble The dinner emphasized relations with air attaches of Allied countries.

Wide World

CESSNA is rolling them out for Canada The Wichita plant builds twin-engine trainers for both U. S. and R. C. A. F.

THE WASHINGTON WINDSOCK

By BLAINE STUBBLEFIELD

Bombers for Crop Dusting

The Stubblefield award goes to the Russian air force officers who, when asked by the Nazis why they had 600 bombers in the Ukraine, said they were to spray the crops

An epidemic of U.S. "blackouts" is to be expected, because they make publicity for the cities and the gents who think them up

Priorities on airlines have already started A couple of operators say the War Department has asked them, in a very nice way, to leave a civilian on the ground and give the seat to an officer A state of emergency could result in the practical exclusion of unofficial travelers from the lines

Transatlantic air freight will be a reality, in the opinion of such men as Glenn Martin, Grover Loening, and others. Loening says planes capable of making 30 trips a year between the U S and England could transport more tonnage than surface ships could carry in the same elapsed time.

Axes for the Axis in Latin America are being sharpened A Bill on its way through Congress authorizes the President to purchase German interests in air lines down there Negotiations will be complicated. But if any of these countries become belligerents against Germany, they will, of course, seize said airlines They could do it anyway just as the U S has already seized Axis ships, and as Mexico confiscated American oil properties Or, if the British-American blockade holds tight, the lines would be starved out for supplies and planes

V.A.S., the Brazilian airline, tried for weeks to purchase transport planes here, but was turned down because State Department said company was German dominated Finally the airline gave up, said it would order Junkers, and to everybody's amazement, got delivery in three weeks—through the blockade

The big risk for transatlantic ferry pilots is not forced landings and German aircraft, but submarines and aerial torpedoes as they return on ships Some have been lost. The return trip by air would be difficult, because of prevailing winds, but the experts are saying we have airplane types capable of doing the job One of these, they say, is the DC-4.

Some underground hangar construction is going on in this country, but where, is not told Engineers seem to agree now that hillside excavation, if in the right kind of soil, is not prohibitively expensive.

Hollywood, we hear, is giving serious attention to the idea of using hundreds of picture preview kleig lights, concentrated in the sky, to dazzle and confuse enemy pilot raiders, if any Throw your lights on Hedy Lamar, Hollywood; *that* will confuse them!

The war over England, in the opinion of some air force officers, depends on whether the Nazis can resume their daylight bombing Indications are that they will try it, sooner or later, because they can't hit enough defense plants at night But it will be difficult, because RAF has plenty of fighter planes now, and is getting more.

In an attempt to stabilize and standardize the top heavy aircraft school industry of Southern California, the Aircraft Schools Association has been formed in Los Angeles with the blessings of the Los Angeles Chamber of Commerce and with Murray Thomas as general manager.

NAA Gains Membership

Washington (AVIATION Bureau)—National Aeronautic Association was expecting record attendance at its Louisville convention and forum, which will have come to a close when you read this. Air Defense of the Hemisphere was the keynote. Among the speakers were Col John Jouett, president of the Aeronautical Chamber of Commerce; Thomas H Beck, publisher of Collier's magazine, Leslie E Neville, Editor of AVIATION magazine, Gill Robb Wilson, president of NAA

Two new NAA chapters have recently been accredited: Bowling Green (Ky.) Aero Club with 32 members, and the Greater Twin Cities Chapter, which has organized with 84 members in the Minneapolis-St. Paul area. Others are being formed in several areas. It takes 25 members to start a local organization. Membership has grown at an increasing rate over the past eight months. Estimates for April show a net gain just short of 1000 new members.

NAA officially takes the position that Army and Navy should modify its requirement of two years college for aviation cadet candidates. The Association contends that the college training does not necessarily develop the leadership and responsibility necessary for success as a military pilot.

National Intercollegiate Flying Club, a division of NAA organized in 65 colleges, recently held its seventh conference in Detroit

NAA Contest Board

National Aeronautic Association has named its Contest Board for 1941-42 to supervise aircraft record trials and sanctioned air meets in the U. S.

CALLING NAMES

Carl Griffin advances to position of divisional dispatcher for eastern division of Northwest Airlines. **LeRoy Petersen** to schedule clerk on the eastern division succeeding Ronald Strixig who is named chief dispatcher of the western division

Douglas Fairbanks flies Pan American Airways route around South America on his mission as cultural envoy to Latin America. He was appointed by President Roosevelt.

Robert Leighton, auditor of New York traffic office of United Air Lines, is a student pilot in the Canadian RAF

Edgar J. Lesher and **Paul H Higgins** are added to the staff of the department of aeronautical engineering at the A & M College of Texas

Capt. Cecil M. Hefner, who flies Flagships for American Airlines, made the Satevepost in an article Men at Work April 19th issue.

British Combine

GUN TURRET of a Consolidated Catalina flying boat, as used by the British for submarine patrol over the North Atlantic.

Harvey H. Bundy, former Assistant Secretary of State is appointed special assistant to Secretary of War Stimson

Alexander N Hemy is elected to the board of directors of American Airlines.

John Fiske is elected to the board of directors of Colgate-Larsen Aircraft Co

Robert T. Bowman is appointed director of public relations for John A. Roebling's Sons Co

Jack A. Tompkins, assistant to **J. H. Theilig** in American Airlines Agency & Foreign Dept., is promoted to assistant district sales manager at Chicago. **Joe Terry** succeeds him

Walter L. Brown takes office as vice pres and general counsel of Western Electric Co

Beckwith Havens observes his 30th anniversary as a commercial pilot—has logged 4000 hours and still flies as northeastern distributor for Fairchild

Carl J Andrae becomes assistant sales manager of Wilkening Manufacturing Co's replacement division.

Ten employees of American Airlines receive their ten-year service pins in April, bringing the total to 371

R. E. Johnson, engineer of the aeronautics division of General Electric is made assistant engineer of the aeronautics department. **A. M. Delehanty** is named assistant engineer of the aeronautics division

Frank W Curtis is elected president of the American Society of Tool Engineers. **E W Wieter** and **R. H. Morris,** vice presidents. **C. L. Hause,** secretary. **F. R. Crone,** treasurer

George A Martin, board chairman of Sherwin-Williams, receives annual award for public service from the Cleveland Chamber of Commerce

J C Hansen, sales manager of Hansen York wins Yale & Towne contest for name for their small electric hoist—his entry, Midget King

William L Ludwick is appointed chief engineer of the instrument division of Thomas A. Edison Inc

Edwin H Price, Los Angeles representative of Manning, Maxwell & Moore and Lieutenant Commander, USNR, is now stationed at San Francisco plant of Bethlehem Shipbuilding Corp

J. Lewis Reynolds, v.p. in charge of export sales for Reynolds Metals is appointed general sales manager

Major Stanley Umstead, chief test pilot of Air Corps, and **O W Coyle,** Douglas test pilot, will handle controls of the B 19 on initial takeoff flight.

James H Redding, former assistant chief of CAA Aircraft Airworthiness section is added to Headquarters staff of S.A.E.

Brig Gen Ralph Royce is ordered to London for duty as assistant military attache for air. Prior to departure he will be on temporary duty at Wright Field and in the office of Chief of Staff Wash

W. H. Angell, Jr becomes associated with Morrow Aircraft Corp

Squadron Leader C F Snowden Gamble, publicity manager for Imperial Airways died while serving with the Royal Air Force

Laurence J Martin joins the executive staff of OPM to handle new metal inventory regulations

Lewis M. Lawton maintains the offices formerly occupied by Lawton & Nicholson (dissolved) at 9 Rockefeller Plaza N. Y. C., and continues to specialize in legal and financial matters affecting the aviation industry

James E Bevan and **W. H. Swojah** are respectively vice presidents in charge of manufacturing and sales for Roller Smith Co

John W Hanes, former Undersecretary of the United States Treasury, is elected a director of Republic Aviation Corp

Maj Gen. James E Chaney is ordered to duty in the Office of the Chief of Staff Washington

O H Niemeyer, R. H Leach, and **R. W Spaulding** are reelected president, vice pres and secretary, respectively of Handy & Harman. **T. M Gallagher** is appointed asst treas and manager of Toronto plant

H W Anderson is made manager of the new aviation department created by Whiting Corp. **George E Bock** becomes chief engineer of the new department

A. Patton Wilson appointed district traffic manager of Trans-Canada with office at 673 Fifth Avenue in New York, in connection opening of TC mail service New York-Toronto April 2 and passenger service May 10

John E Royall elected a director of Menasco Manufacturing Co Burbank.

Merrill C Meigs, Chief of the Aircraft Section of the OPM, addressed 250 members of the Aircraft Parts Manufacturers Association. **L. H. Cameron,** president, presided

Alexander J "Jim" Kisselburgh, former All-American football star from Oregon State, named Cadet Captain of the Air Corps Training Detachment at the Ryan School

Haven B Page resigns as general counsel of the Private Fliers Association and as Washington attorney for Air Associates and assigned active duty Naval Reserve

"Aeronautical Statutes and Related Material" (collected Federal statutory provisions and reorganization plans relating to civil aviation) can be obtained from Government Printing Office for 15 cents each

Ronald W Rich, Jr. announces that the Flying and Ground school course of the Peddie School, Hightstown N. J. has been inaugurated and the first class soloed.

Henry A Roemer, John W Donaldson, Stanley C Morris, Thomas M. Chalmers, all prominent business men have been elected directors of Penn Central

Maj Alexander P deSeversky wins $1000 in 1940 American Design Awards for the greatest contribution to U S airplane design

Air Marshall Billy Bishop, Canadian ace, addressed a banquet of 1300 people in Los Angeles on aid for the Democracies.

Col. H. J. F Miller is designated chief of Maintenance Command for the Air Corps newly created by War Dept., with headquarters at Patterson Field. Four Maintenance Wings will serve under his command, and the Transport Wing now becomes a section of the Maintenance Command

Don A Luscombe, organizer of Monocoupe Corp and in 1935 Luscombe Airplane Corp is now with Reynolds Metals Co as head of the aircraft parts division of the Louisville plant

William C. Gulick is manufacturers sales representative of B F Goodrich Co in its Detroit office

Robert E Doherty, pres of Carnegie Tech replaces **Samuel R. Fuller, Jr** as chairman of Production Planning Board of OPM. Mr Fuller was recently appointed Chief, Materials Branch OPM

Ralph T Seward is made executive secretary of the National Defense Mediation Board of OPM

Coming Events

June 1-4 NAA Annual Convention & American Aviation Forum Louisville Ky

June 1-6 SAE Summer Meeting The Greenbrier White Sulphur Springs W Va

June 7-8 11th National Air Carnival Birmingham, Ala.

June 12-14 Eastern Photoelasticity Conference at Cambridge Mass., under auspices of Dept. Mechanical Engineers MIT

June 28-July 13 12th National Soaring Contest, Elmira, N Y

July 1-6 National Competition Model Meet sponsored by Chicago Times and Chicago Park District, Chicago Ill.

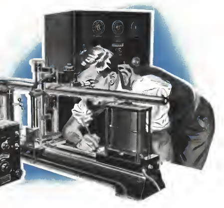
Aug 17-18 Sheldon Air Show Sheldon Aero Club Sheldon, Iowa.

Aug 25-Sept. 2 3rd Annual American Open Soaring Contest, Joliet, Ill.

Sept. 17-19 Nat'l Petroleum Assoc. 38th Annual Meeting Hotel Traymore Atlantic City N J

Oct. 2-4 Nat'l Assoc. of State Aviation Officials Annual Convention Providence R. I.

Oct 30-Nov 1 SAE Nat'l Aircraft Prod. Meeting, Biltmore Hotel, Los Angeles Cal



U. S. Would Buy Axis Out of Latin Air Lines FDR Asks Funds; Suggest Route to Greenland

Washington (AVIATION Bureau)—After almost two years of indecision as to how best to cooperate with Latin American republics in expelling Axis influence in Latin airlines, the government has decided to do the job directly.

RFC, rather than commercial interests, will be used as the corporate entity to handle the task. Contrary to first reports, it is not now contemplated to establish a "U S airline", but to buy out Axis control in local airlines, through a loosely-drawn new bill increasing RFC lending authority. It is expected that each deal will be handled separately, depending on the country involved and the nature of the transport operation. The whole program—to purge Fifth Column activities in Latin American aviation—is viewed as a hemisphere defense necessity.

In addition to financial investment in flight operations, the RFC would also be authorized to aid in pilot and mechanic training and in furnishing needed equipment on more liberal credit terms, and facilitating technical advice.

In a press conference, Jesse Jones, who as Secretary of Commerce is head man of Civil Aeronautics, and is also Federal Loan Administrator hinted that the new bill might also allow RFC to establish airline connections with Greenland or Carribbean areas as a strictly military defense operation, similar to the Air Corps' freight lines to Panama and Alaska.

Defense Aviation Bills

Of several measures well along toward passage by Congress, the most important perhaps is a bill authorizing aviation training of enlisted men and creating a new pilot group within the Air Corps composed of non-commissioned officers. The Army claims that "the proportions of the expansion program" and the successful use by other countries of noncommissioned officer pilots inspired the move.

Another bill creates the grade of aviation cadet in the Air Corps, placing Army flying cadets on a parity with Naval and Marine Corps aviation cadets, with the same allowances for Army reserves as Naval and Marine reserves when on extended active duty.

Still another measure increases the pay of parachute troops, adding $100 a month for officers and $50 for enlisted men, while a fourth bill raises the number of enlisted men who may be detailed as students at technical institutions.

Separate Air Force Is Proposed Again

Pressure for a separate air force is building up heavier than ever, but War and Navy opposition is still thought strong enough to block any such move.

Forerunner to further cracks at our aviation set-up was a recent speech by Rep. Scrugham, chairman of the House Appropriations Naval Subcommittee, who complained bitterly against the expense of duplicate army and navy aviation facilities. About the same time Rep. Jennings Randolph (D., W Va.) introduced a bill disregarding naval aviation but proposing a separate military air force.

On the other side is the widely accepted theory that a separate air force is a dead issue today anyway, since neither Congress nor the Departments are holding the air forces down but are rushing in with all the money and authority air officials want. Proponents of this opinion believe the matter is a policy rather than a tactical question, emphasizing that from the strategic point of view some top chief commands both Army and Air Force anyway, so that it would make little difference whether they were separate or unified.

Navy Aero Bureau Gets $434,550,000

As the House Appropriations Committee began hearings on the War Department supply bill for fiscal year 1942, the President signed the Navy's appropriation bill already through Congress.

For aviation, the Navy is provided in this bill—exclusive of substantial funds in various supplemental defense appropriations—with a total of $434,550,000 to be divided: $350,372,000 for construction of aircraft, $71,972,400 for maintenance and operation of aircraft, air stations and aviation installations on shipboard, and $9,500,000 for experimental work.

Meanwhile, the House Naval Affairs Committee is recommending authorization of 11 lighter-than-aircraft bases to be used by the 48 lighter-than-air craft for which the Navy already has Congressional approval. Six of these are now on order and it is reported that 21 more will be built this year, the remaining 21 next year. Funds for construction of the bases, if approved by both houses, will probably be granted in a supplemental defense appropriation yet to come before Congress.

Naval Aeronautical Academy, proposed to be established in the San Diego Bay area, is opposed in a report by the Navy.


Wide World

AT DAYTON, Ohio, the Air Corps conducted ground tests with this Curtiss P-40 to check accuracy of machine gun fire.

AIR SCOOPS

Air corps observers from various pursuit and bombing groups are being sent to England for duty. The purpose is to obtain their reactions to air war over Britain, and to obtain information about the performance of British and U. S. aircraft. They are practically in combat training.

Barrage Balloon Training center, designed for initial student body of 80 officers and 750 enlisted men has been set up at Camp Davis, North Carolina. Balloon defense has been transferred from the Air Corps to Coast Artillery. Colonel Robert Arthur, CAC, is commanding officer of the Center. Balloons are used as a deterrent to dive bombers.

Lighter-than-air bases, near San Francisco, Elizabeth, N. J., and at South Weymouth, Mass., will be established if a bill, approved by the President, is passed by Congress. The lighter-than-air program of the Navy calls for eventual fleet of 48 ships. The base bill authorizes expenditure of $17,000,000.

Self-catapulting gira, built by Pitcairn-Larsen, has completed a series of tests for the Army. It is all metal, takes off and lands vertically, performs on a 35 x 45 foot area, on rocky and soggy or plowed ground. Has interesting defense possibilities, seems strong competitor for helicopter.

Floyd Bennett Field, acquired by the government, is about to become one of the greatest of U. S. Naval bases. The Navy's seaplane squadron here, in charge of neutrality patrol of the area, is geared to handle 24 planes, and a second fleet of Consolidated PBY's was due at this writing. Floyd Bennett is the jumpoff for delivery of planes to Britain. Large fleets of Consolidateds, and Boeing four-motored bombers are arriving for checking in by British pilots. Private training schools must go.

A Maintenance Command of the Air Corps, under jurisdiction of the Chief of the Materiel Division, has been created by the War Department. Duties are to assist the Chief in storage, issue, repair, and maintenance of all supplies and equipment of the Air Corps.

Vultee Announces New Dive Bomber

At the dedication of the new Vultee plant in Nashville on May 4, President Richard W. Miller announced that his company was going into immediate production on a new dive bomber, ordered in considerable quantity by the British. Called the "Vengeance", the new plane is said to be a more deadly weapon than any other ship of its type.

Most interesting feature of the new ship is its wing design, which company officials report as being a modified gull-wing combined with unusual sweep-back characteristics The Vengeance has a 1,600 hp. Wright engine and can carry a bomb load of some 1,700 lb. within the fuselage Range is said to be considerably in excess of the 500 miles of the Stukas The plane has fire-power said to be in excess of other dive bombers, and is well armored

The first two models were built in Vultee's factory at Downey, but production models will be built at Nashville and by Northrop Aircraft. Vultee expects to subcontract about 40 percent of the ship, wings in Michigan and Indiana, and tail surfaces in Florida The Nashville plant, which measures 970 x 700 ft., will reach full production in October, at which time it will employ 7,000 men High production tooling, the extensive use of conveyor belts and other production methods worked out by Vultee engineers will speed manufacture. Annual capacity of the Nashville plant is said to be about $50,000,000 At present the factory is also building the O-49 observation plane for the Air Corps

WORLD'S LARGEST MAGNESIUM FACTORY (113,000 sq. ft.) is completed by Wright Aeronautical at Fair Lawn, N. J. Under Alexander McIntosh, superintendent, 650 workers will produce about 150 magnesium parts for Cyclones and Whirlwinds and by early 1942, 60,000 lb of metal are expected to be poured daily.

New Producers Sought For Big Propellers

Washington (Aviation Bureau) Further to step up production of propellers, OPM is working on plans to have firms outside the aircraft industry manufacture complete propellers under license—in much the same way that Buick, Studebaker, and Ford are now preparing to manufacture P&W and Wright engines

Propeller production, running about 2,600 a month in the larger sizes, is keeping fairly well in step with output of engines, which is of course the objective to be met However, shortages are showing up occasionally in specialized types The most publicized example occurred at Martin, where a dozen or more B-24 medium bombers were completed before the four-bladed props they use were available

Expansion of propeller output to date has been achieved almost entirely by expansion of the plants of the two main producers, plus some sub-contracting Curtiss Propeller Division of Curtiss-Wright has expanded floor space from 17,000 sq ft. thirty months ago to about a million feet, with further expansions scheduled which will bring the total to nearly a million and a half

Hamilton-Standard, the other producer of military size props, has now expanded to a little under a half million square feet and is producing some 2,000 propellers a month.

This tempo of expansion will be stepped up in July by the entrance of a new large-scale producer, when General Motors' Aeroproducts Division goes into production on its own design of combat-size prop in a 200,000-sq.ft plant at Dayton, Ohio Negotiations are already under way for doubling the size of the Dayton plant

Lockheed's All-Out Production

Following the President's recent plea for "all-out" production, a statement was issued by Robert E. Cross, president of Lockheed Aircraft Corp., illustrating how fully his firm is already on such a footing For several months Lockheed, and its subsidiary Vega Airplane Co., has been on a three-shift basis On May 1st there were 10,000 men on the Lockheed-Vega night shifts adding their efforts to the work of 19,000 day workers Said Gross, "We are training men, and hiring trained men, just as fast as we can We have more than 8,000 employees attending trade extension classes in the city schools of Burbank and nearby communities, and are hiring at the rate of more than 2,500 a month In fact, in the month of April we hired 3,540 men.

"Lockheed is on an 'all-out' footing We are driving toward our objective of filling out our complement of personnel to three full shifts working 24 hours a day on military aircraft for the United States Army Air Corps and the British Royal Air Force"

Manufacture of "Sabre" Still Under Study

When Lord Beaverbrook announced that the Napier Sabre engine is to be built in this country, he was apparently somewhat ahead of the facts Defense officials here say that although the possibility is still being considered, no decision has yet been reached. One of the engines was brought here for study some months ago, and although the initial impression that the engine was too hopelessly complicated ever to be a production proposition seems to have worn off somewhat, a lot of people are still very dubious about it

The Sabre is a liquid-cooled engine of low frontal area, with 24 cylinders arranged in four banks in an H pattern on two crankshafts geared together It achieves its small size by a very high speed—somewhere between 4,000 and 6,000 rpm This compares with the 3,000 rpm. developed by the Allison, the fastest of big U. S engines.

The engine develops 2,000 hp., according to Beaverbrook It is understood that the Sabre is not yet a production engine, that only experimental models have been built in England The British intend to use the engine in the new Short-Stirling 50-ton four-engined bomber

Beaverbrook indicated that, as built here, the Sabre would go into a U. S. plane. Some new ship would, of course, have to be designed around it.

Nine Coast Firms Add $1,000,000 Weekly Pay

Pacific Coast aircraft builders continue to pile up impressive records of production progress A survey of nine Pacific Coast aircraft firms by the Aeronautical Chamber of Commerce shows that they added almost a million dollars to weekly payrolls during the first quarter of 1941, and that total new employees added during this period were 19,309 Weekly payrolls of these firms have risen almost 600 percent in little more than two years. Total employees as of April 1st, 1941, were 101,548, and it is predicted this figure will reach 175,000 before the end of this year Meanwhile the aggregate backlog of these same firms has increased from $84,246,330 on January 1, 1939, to $1,558,382,861 Despite rapidly rising output of aircraft it is estimated that this backlog figure will increase to more than $2,000,000,000 in the near future Backlog of Douglas Aircraft Company alone has now passed $400,000,000

Roosevelt Plane Roundup

Requisition of two-engined airplanes by the Administration under Lease-Lend, presumably for Britain or China, put the project in the category of military secrecy. It has been im-

possible to check figures as to the number obtained In response to the President's call, the airline heads met in Washington with Civil Aeronautics Administrator Gen Donald Connolly

Certain officers of the airlines told AVIATION that no pressure was brought on them The lines gave their full cooperation In this they served their best interests, for they want to avoid requisition by the Government of new planes on order They expressed opinion that the Administration does not now intend to take any of their DC-3's, old or new But plans could change over night.

An airline executive further explained that the Administration got 20 planes in all, including DC-2s, Lockheeds, but no Boeings There are no figures on the take of privately-owned planes You can assume that the Administration will buy all the useable ships it can find, and the statistics will be changing from day to day

Official sources estimated there are 33 DC2's in possession of the airlines, and 30 Boeing 247's It seemed evident at this writing that the Administration did not want the Boeings

Incidentally, the airlines are not so hard up for airplanes as most people think The real bottleneck is pilots One of the major lines says it is flying its equipment 10 hours a day, and this can be pushed up to 13 by adding maintenance force It is surprising, they said, how many passenger hours can be added by a small increase of ships' hours in the air

Dual Bearing Indicator

An automatic dual radio bearing indicator is being demonstrated throughout the country by the Civil Aeronautics Authority The instrument makes radio range beacons out of any radio stations, commercial or airline range It may become standard equipment on the airlines, and for military and civil air navigation

The "dual" feature—ability of the device to be tuned in on two stations at once, with one of its two pointers pointing at each station—makes triangulation available to the navigator In the case of a direct course between two stations, the pilot has only to keep the two pointers 180 degrees apart on the dial This is different from the simple homing compass, with which drift cannot be counteracted

The indicator was developed by CAA, in cooperation with private concerns, at a cost of $13,500 It is being shown by

'CHUTISTS AT LAKEHURST MARINE TRAINING SCHOOL go up about 12 at a time in a military version of the DC-5

Reeder G Nichols, chief, radio section of the air carrier division, in CAA's new DC-3 laboratory plane

Silvaire Master

New Silvaire "Master", is the 1000th all-metal Luscombe It is powered by the dual ignition 65 hp Continental, has a level speed of 115 m p h. Landing speed is 37 m p h The 15 gal fuel tank aft the cabin gives a range of 350 miles.

Twin mufflers are standard and a simple mechanical starter is also provided A further improvement is the new balanced airliner type trim tab operating on a worm gear mounted between the seat cushions Tab gives finger-tip control and eliminates the former bungee arrangement. Greater visual range is provided by use of a molded "Vinllyte" windshield.

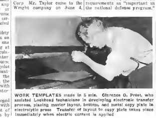
2 Vice Presidents Named By Wright Aeronautical

P. B. Taylor, assistant general manager was elected vice president and William D. Kennedy sales and service manager, was named vice president in charge of sales of Wright Aeronautical Corp Mr. Taylor came to the Wright company on June 4, 1922 as test engineer and was promoted until he became chief engineer He was recently appointed assistant to Myron B Gordon vice president and general manager. Mr Kennedy joined Wright in 1928 after 16 years in aviation and industry For 11 years he has directed the world-wide servicing of the Wright corporation's engines He succeeded George F Chapline, former v p. of sales, who became president of Brewster.

CAA Gets Priorities On Air Aid Equipment

Under a new official ruling, CAA orders and contracts may be given preference ratings by the Priorities Committee of the Army and Navy Munitions Board without need of separate applications on each order

Such automatic preference ratings apply to radio and lighting equipment and other materials on the so-called "critical" list Thus CAA will be able to avoid temporary difficulties in acquiring airway installation supplies, as occurred recently in connection with radio range beacon work The ruling, issued by E R. Stettinius, Jr., Director of Priorities, identifies CAA requirements as "important in the national defense program."



WORK TEMPLATES made in 5 min. Clarence O. Prest, who assisted Lockheed technicians in developing electronic transfer process, placing master layout, bottom, and metal copy plate in electrolytic press Transfer of layout to copy plate takes place immediately when electric current is applied

ASSEMBLY LINES

By Robert Colborn

Aluminum requirements for CPTP airplanes have been provided under an A-10 priority rating and about 53,000 lb. per month have been made available, subject, of course, to future change. Orders for airplanes from Civilian Training contractors must be certified in order to receive this priority Allowance of 105 lb per plane has been made for primary trainers for Class II ships with a 20 percent allowance for spares in each case. Aircraft outside of CPTP have a B 8 priority rating which provides little or no aluminum, but it is hoped to obtain a B 4 rating which should afford 60 percent of normal demand for primary aluminum and unlimited quantities of secondary aluminum Some plane manufacturers are reported to be redesigning to use smaller quantities of light alloys

Prototype of Republic's newest ship, the XP-47B is now being tested by the Air Corps; (see photograph top of page 130.) A single-place pursuit, it is the Army's version of a ship built around Pratt & Whitney's 2,000-hp. radial engine and is thus roughly equivalent to the Navy's Vought-Sikorsky shipboard fighter No information has been released about the P-47 except that it is of all-metal construction, has a four-bladed prop, is comparable in weight with Lockheed's twin-engine P-38, and "will be heavily armored and have strong fire-power from large and small calibre guns." It is believed, however, to resemble the P-43 "Lancer" on which Republic is now in production, which is powered with a 1,200 horsepower engine.

Although aircraft production has now caught up to the schedules established late last summer rumors are persistent that a major change is impending in the Washington organization directing the plane program Creation of an undersecretary for air in the War Department is seen by some as indicating a shift in control to the services rather than the Office of Production Management.

Control over the plane program now is split between several committees, each made up of representatives of Army, Navy, OPM, and the British, with the OPM people doing most of the work. The situation has been further complicated by creation of the Lease-Lend Administration outside OPM. And within OPM the aircraft group ranks far down in the hierarchy

Liaison planes, for carrying generals and messages short distances and landing in small fields, are a type first extensively used by the Germans in Poland. The Air Corps is developing several models, of which first to get publicity was the Ryan 0-51 "flying motorcycle" Latest is a Bellanca, the 0-50, which is now undergoing flight tests It is an externally braced high-wing monoplane, fabric-covered except for the leading edges of the wings Has flaps and slots Also under test is Curtiss' version of the liaison ship, the 0 52 It is a high-wing, strut braced monoplane with three bladed propeller and retractable landing gear It can be equipped with machine guns. It is somewhat smaller than the 0-47B now used by the Air Corps

Fairchild's primary trainer, distinguished by its plastic-bonded plywood wing surfaces, is being flight tested in a version (the XPT-23) powered by a Continental radial engine The Fairchild trainer, a low-wing monoplane with a fabric-covered steel tube fuselage, is being turned out with Ranger in-line engines, under the designation PT-19, at a three-a-day clip It weighs 2,450 lb

A lighter trainer, Ryan's PT 21, is also being tested This 1,750-lb ship is a low wing monoplane with metal monocoque fuselage and fabric wings It is powered with a Kinner radial of either 132 or 180 hp

Standardization of riveting procedure is aided by Douglas' release to the industry of its patented flush-riveting process The Douglas process, already widely used, would permit standardization on the 100 deg rivet, other processes available use different rivet shapes

Douglas is helping out it's new assembly workers, to whom standard shop drawings are sometimes rather baffling, by providing cut-away perspective drawings of parts and assemblies, showing at a glance how things go together.

Ford's experimental liquid-cooled engine is reported scheduled to go on the test block in June

Legal technicalities have required that when airplane contracts provide for partial payments as the work progresses, an arrangement likely to become more common with increasing subcontracting, payment and completion bond must be furnished by the contractor Congress has passed a bill waiving this requirement.

Plant expansion is beginning to be a story of finished plants as well as of contracts awarded as the industry swings into real quantity production of aircraft Dedication of Vultee's Nashville plant is noted elsewhere in this issue, and manufacturing at Wright Aeronautical's 2,120,000 sq.ft engine plant at Cincinnati is now well started The first engine is to be turned out in June, with an ultimate capacity of a thousand 14-cylinder 1,200 hp engines a month Initial machinery installations are on the pilot line principle—one of each type of tool, so that work can start immediately

Curtiss-Wright's propeller division has dedicated its fourth plant, a 338,000 sq ft structure at Caldwell, N J

Northrop Aircraft's production space was expanded 150 percent with completion of a 247,500-sq ft. building at Hawthorne. Installation of tools and jigs will be finished in July and the first of the Vultee dive-bombers to be built under license will be ready this fall.

Lockheed has completed a 96,000 sq ft service hangar said to be the first manufacturer's building designed solely for servicing planes. It will accommodate twenty transport-size ships. Lockheed's 1,220,000-sq ft Vega plant is due to open in July.

Goodyear has started work on a $3,700,000 plant at Akron for manufacture of plane parts The 400,000-sq.ft. structure is being financed by RFC's Defense Plant Corp It will be used to make parts for Martin medium bombers for assembly in the new government-owned assembly plant. Goodyear has already received an educational order for outer wing sections

Construction is underway on a new plant for Brewster at Johnsville, Pa The plant will add 450,000 sq ft. to Brewster facilities.

Pullman Standard Car Manufacturing is to build parts for Douglas planes in a $1,109,000 plant to be financed by Defense Plant Corp

It's not an airplane, but a Lycoming engine is being used in a propeller-driven "snoplane" on skis being marketed in the West

Canadian Aviation News

By James Montagnes

Canada's total airplane orders for 1941 will be in the neighborhood of $100,000,000, according to an announcement of Munitions and Supply Minister, C D Howe The airplane program includes orders for at least $50,000,000 to Canadian plants Long range bombers will cost about $30,000,000 Several large orders for other types of bombers, trainers and fighters were to be made early in the summer, he stated. Canadian Vickers was given a contract for 30 bombers with a range of 3,500 miles

Trans Canada Airlines, the government-owned coast-to-coast service, is now on a complete transcontinental service, with opening of the Moncton, N. B., to Halifax service. The extension brings Halifax and Vancouver little more than 24 hours apart by air There are now two round trips daily from the Atlantic to the Pacific, and five round trips between Toronto, Ottawa and Montreal Extension of the service between Toronto and New York has been permitted by Washington With extension of the service to Moncton, a new central passenger reservation control system has been installed at Toronto, which is connected by direct teletype with all ticket offices and airports throughout the system. The central control will be able to determine within 30 seconds whether space is available on any trip a passenger may desire to take.

Civil aviation in Canada in 1940, according to figures just released by Ottawa, flew a total of nearly 12,000,000 miles, a 16 percent increase over 1939 Revenue passengers increased from 110,882 in 1939 to 137,890, with the average journey of revenue paying passengers increasing by 76 percent Freight carried showed a drop to 16,700,000 lb as against 21,250,000 lb the previous year Mail increased by 57 percent to a total of 2,738,000 lb Major companies showed different conditions of increase and decrease Canadian Airways Ltd, largest private operator, showed increase in passengers and freight carried, but reduction in mail flown.

Production of North American Harvard trainers and Noorduyn Norseman aircraft is proceeding at an augmented pace as employee efficiency increases, R B C Noorduyn, vice-president and general manager of Noorduyn Aircraft Ltd, Montreal, told stockholders at the annual meeting on April 29 Contracts had been placed to build an additional 101,400 sq. ft. of floor space On completion of this unit actual manufacturing floor space would be 275,000 sq ft. Employees increased from 1,465 at the beginning of 1941 to 1,879 at end of April.

Delivery has started on the 24 Northrop patrol bombers ordered by Norway for use in its new air force being trained in Canada The bombers carry a crew of three, six machine guns, a ton of bombs, and fly 250 m.p.h. with floats The bombers will be used in Canada for training, but will eventually be taken on to Britain for use by the Norwegian command there This also applies to the Douglas attack bombers and Curtis P-38 fighters now being used by the Norse in Canada

The University of Toronto's physics department will be geared to air force training this summer, according to Dr. E F Burton, department head. Five hundred recruits will be given intensive training in radio work in a 13-week course starting at end of May

The Royal Canadian Air Force has adopted the Fairchild FM-32 as its standard trainer for elementary flying, succeeding the Fleet and de Havilland Tiger Moth biplanes

On Schedule

In the last issue mention was made of steps taken by Latin American nations, in particular Peru, to curb Axis owned or controlled airlines in this hemisphere. On the first of this year, these airlines covered more than 20,000 miles on regularly scheduled flights, but since then there have been developments which are steadily reducing these networks In the first place probable amendments in the RFC law would permit this body to finance airlines in this hemisphere, making routes possible which would otherwise be of little value, except for flagshowing, or which could not be profitably operated because of competition by foreign-owned airlines, who can cut rates to the bone because of practically unlimited subsidies In the second place, Bolivia is taking final steps to take over completely the Lloyd Aereo Boliviano, and though not a major acquisition because of the airline's bad financial shape, it does mean the elimination of another German-controlled airline in Latin America. Thirdly, the Sedta, operating in Ecuador, has received its last shipment of gasoline from a company which is Canadian-controlled, and cannot obtain fuel from any other source, operations are therefore being stopped as soon as this supply runs out

A further development was the refusal of Brazil to allow the Air France to reopen service from Rio de Janeiro to Santiago via Buenos Aires; this appears to coincide with reports that the Air France is now completely German-controlled, and may try to resume old services abandoned by the original company. These developments leave no German controlled airlines in operation in the Northern part of Latin America.

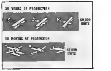
England's top aviation publication "The Aeroplane", made mention of this column some time ago, in connection with Latin American developments, and Pan American's sale of three Boeing 314A's, with the reportedly bigger and better equipment that is in the offing Recent publicity cannot have left much doubt in the minds of the editors Pan American has ordered forty Lockheed Constellation Model 49 43-ton landplanes, and is revamping most of its seaplane bases, hoping to get these giants in the air by the summer of 1942 In comparison to these leviathans, the Boeings, which cost Panam a total of $780,000 each when put into service, according to some one who ought to know, are well on their way to obsolescence

In 1938, Lockheed Aircraft Corporation converted the first Model 14, which had been used for the various tests necessary with a new type, to a special cargo airplane with a large hatch and fuselage clearance, planning to enter it into an Army competition The actual plane apparently was not acceptable to the U S Army, and after flying around Southern California for some time, the Model 14-C disappeared to regions unknown

A recent story coming out of Central America tells how this plane is in use with American Export's T A C A for heavy cargo loads, and is transporting mining machinery with weights in excess of 5000 lb. per piece The fact that this airplane was converted especially to carry airplane engines and propellers, and stressed to carry large loads in the cabin should come in well with T.A.C.A.'s operations, which still cover heavy cargo hauling on most local routes.

British Combine

BRITISH use this Snargasher twin-engine trainer for advanced instruction. Ship has two 205 hp. D.H. Gipsy air cooled engines, seats three in tandem, cruises at 190 m.p.h.



RALPH S. DAMON (above), vice pres of American Airlines, is on leave of absence to assume presidency of Republic Aviation Corp. **W. W. KELLETT**, president, advances to Board Chairman.

From Lycoming Division of Aviation Mfg **GLEN T. LAMPTON** goes to Hamilton Standard as assistant engineer, in charge of experimental engineering and revision of the Engineering Department.

As general manager of Kinner Motors **EARL HERRING** has successfully handled operations since the new corporation assumed control and in recognition has now been elected executive vice president.


OPM Defense Photo by Dunn

The 1940 Gantt Medal for leadership in industrial management was awarded by A.S.M.E. and the Institute of Management to **WILLIAM L. BATT**, president of SKF, now deputy director, OPM.

H. OLIVER WEST, assistant to the president since 1939, was elected executive vice president of Boeing Airplane Co. and its subsidiary, Boeing Aircraft Co. All the directors of the company were reelected.

ROBERT L. EARLE, vice president of Curtiss-Wright Corporation since 1939, and general manager of its propeller division since 1938, has been elected a director of the Curtiss Wright Corporation.


Two Eastern Airlines meteorologists honored: **JOSEPH J. GEORGE** (1), chief meteorologist, has been loaned to the Weather Bureau at the request of Cmdr. Reichelderfer, to expedite special fog studies. **JOHN RANDLE DEHART**, meteorologist at Miami, received the first annual award of the Air Transport Association to airline employees "for best original research having practical application to meteorology and dispatching."

SAMUEL J. SOLOMON (above) succeeds **PAUL F. COLLINS** (now board chairman) as president of Northeast Airlines. He is manager of Washington Airport and vice president of Boston-Maine Airways.

From crew chief in 1935 to superintendent of maintenance is the record of **CHARLES JOHNSON**. Newly promoted to the office by Braniff Airways, he succeeds Stanley R. Shatto, resigned.


Harris & Ewing

New air transport division of Matson Navigation & Inter-Island Steam Navigation is under direction of **CLARENCE M. BELINN**, former vice pres & gen mgr. of Kansas City Southern Air Lines.

CLEEMAN WITHERS (above) resigns as vice pres. of Sperry Corp. to become vice pres. of United Aircraft Products Co. **FRANK G. SORENSEN**, a director since 1929, is elected president.


Harris & Ewing

KENDALL K. HOYT (above) is appointed assistant secretary and assistant manager of NAA during leave of absence of **LT. COL. G. DEFREEST LARNER**, serving in London as Asst. Military Attache.

Growing Latin American traffic along Braniff Airways' route results in the appointment of **DOUGLAS C. L. STOCKDALE** as Mexico Traffic Manager. A new Mexico City office is soon to be opened.

DEVON FRANCIS, aviation editor for Associated Press, flew a Piper Cub for delivery to E. W. Wiggins Airways, earning from W. T. Piper a scroll designating him Honorary Ferry Pilot No. 1.

Flexible Hose Lines

By F Peter Hirsch
Consulting Engineer, Aeroquip Corp

The Aeroquip Corporation of Jackson, Michigan, has recently started production on new hose lines and fittings, which have already proven their practical value in widespread use in Europe over a period of several years

One of the main problems in developing flexible hose lines has been to find the right kind of synthetic material for the inner tube of the hose, which has to stand various liquids, such as gasoline, mineral or vegetable oil, hydraulic fluid, alcohol, fire extinguishing medium, de-icing fluid water, glycol, etc., under all practical temperatures, without either deterioration, disintegration, or swelling

The B F Goodrich Company has recently developed a synthetic material called "Ameripol," which was found to be the most satisfactory The Aeroquip hose consists of an inner tube made of this Ameripol compound and three plies of braided cotton impregnated with the same compound material

One of the new and unique features of the fittings is that the internal bore of the nipple is equal to the internal diameter of the hose Aeroquip Hose Lines therefore allow a full flow, because the bore of the nipple is identical with the internal diameter of the rigid line with which the hose line is intended to be used

Another remarkable feature of the fitting is the easy method of assembly Fool-proof in every respect, the fitting can be attached and detached from the hose as often as desired by unskilled labor in the field It is not essential to provide ready, made up hose lines for spare parts for every individual application in every type of airplane, as the field service can store coils of hose and standard types of fittings. This is perhaps the outstanding improvement, at least from the military point of view. The spare part supply system can further be simplified as the Aeroquip Hose is made to operate under practically all pressure conditions The inner tube is secured to the outer braids in such a manner that it does not collapse even under extreme vacuum. On the other hand, the three cotton plies provide the hose with sufficient strength to be used in hydraulic systems with operating pressures of 1500 lb/sq in. and above. Aeroquip Hose Lines are therefore universal all-purpose hose lines in the true sense.

Last but not least of importance is the weight factor In comparing conventional type hose lines with Aeroquip Hose Lines it will be found that the latter allow a saving in weight of up to 50 percent. This has been achieved by using fittings made of heat treated aluminum alloy, and also by using hose of the same bore as the rigid tube with which the hose line is intended to be used For instance, on a ⅝" O D rigid tube with ½" bore, an Aeroquip hose line with ½" I D can be used, while conventional type hose lines have to be made of ⅝" I D hose Decreasing the I D of the hose results, in reducing size and weight of hose and fitting

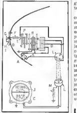
In comparing other characteristics of the Aeroquip Hose Lines with any of the conventional type hose lines, one has to take into consideration that in Aeroquip Hose Lines always the next smaller size hose is being used. In consequence, burst pressure, volumetric expansion and other factors depending on the I D of the hose are all improved without increase of either amount of material or cost.

Ice Warning Gage

To relieve the pilot of guessing whether ice is forming on the wing of his ship, an ingenious device has been designed by Air-Safe Aircraft Instruments When the first film of ice forms on the leading edge of the wing, the pilot is warned by a red light on his instrument panel And if the plane has the equipment, this device will also turn on the de-icers

The indicator operates in the following manner

At 36 deg F, or lower, the thermostat contacts (A) are closed, energizing the 24 volt electric motor and it rotates. Current also flows through the lower globe (C) behind the ground glass and an orange light illuminates the symbol "36°F" marked on the gage on the instrument panel Current also flows through a resistor (D), brush contact (E), flexible coil spring coupling (F), rotating arm (G) and contact button (H) to ground on contact disc (I) on the wing's leading edge. If and when ice forms, the contact button skids over the ice and is thereby insulated from ground contact This raises the voltage across the upper globe (J) behind the ground glass and a red light illuminates the warning signal, "Icing".



CIRCUIT DIAGRAM of Aircraft Icing Indicator designed to relieve the pilot of guessing about ice formation (A) Thermostat set to close contacts at 36 deg F, (B) 24 volt motor, (C) orange globe on indicator dial; (D) resistor, (E) contact brush, (F) flexible coil spring coupling; (G) rotating arm; (H) contact button, (I) contact disc; (J) red warning signal; (K) 24 volt battery lead, (L) plug and socket, (M) 24 volt battery

The Holzapfel Mfg Co, of Los Angeles, Calif, is manufacturing the device

LYCOMING'S electrical run in stands for engines 50 a day can be handled.

Lightplane Engine Run-In

What is believed to be the industry's only battery of electrical run-in stands is used by the Lycoming Div of Aviation Mfg Corp at Williamsport, Pa, for the "break-in" run of 55- and 75-hp Lycoming engines

Tests have shown that this "cold" run-in for a period of six hours, followed by operation under the engine's own full rated horsepower, produces far better results than when the engine is operated entirely on the test stand under its own power.

Before beginning its electrical run in each new Lycoming engine is completely assembled, including oil accessories, and is equipped with an oil filter to pick up any dirt or chips which may be in the engine. Fresh oil is then circulated through the engine while it is operated electrically at a speed of 1700 r p m. A flexible coupling drive is used between the electric motor and engine, and a pressure switch is connected between the oil pressure line and motor switch to automatically cut off the motor if the oil pressure drops below normal operating point

Lincoln Welding Program

Added stimulus to the study of welding in the aircraft field is provided by the James F Lincoln Arc Welding Foundation which announces that papers entered in the Summerill Tubing Company's contest will also be eligible in the $200,000 Industrial Progress Award Program sponsored by the Lincoln Foundation Papers entered in the Summerill contest might require a few changes or additions to make them acceptable to the Foundation, but it is quite possible no alterations would be necessary

Contestants should communicate with The James F. Lincoln Foundation, Cleveland

TRANSPORT AVIATION

Senate Committee Studies Airline Accidents Opinion Differs on Characteristics of DC-3

Washington (AVIATION Bureau)—Special Senate committee has been investigating airline accidents and testimony up to this writing dealt largely with technical matters, and very little with the political controversy over the Administration's reorganization of the Civil Aeronautics Authority, which had been blamed for the airlines troubles

Considerable interest centered around the introduction of a confidential report, written by the National Advisory Committee for Aeronautics in 1937, following tests of the flight characteristics of the DC-3 These tests were made voluntarily by NACA, at a time when it was assembling data on other commercial and military planes, especially low-wing multi-engine types.

The report was submitted to Army, Navy, Bureau of Air Commerce and several airlines upon completion. A motion picture showing the stalling characteristics by means of yarn-tuft on the wings, showing the wings approaching the stall and in the stall, also was made and submitted to the airlines which used it in pilot instruction

Dr. George W. Lewis, director of research of NACA, told the Committee that the DC-3 report was not part of his agency's annual report to Congress, and was still confidential, so far as NACA was concerned Nevertheless, the Senate Committee entered it in the public record

Report beneficial to airlines

Dr. Lewis stated to the committee he felt it was not NACA's responsibility to take action any further than to reveal its findings to manufacturer and operators and governmental agencies concerned. Beyond that he had no comment. NACA stands by its report, however, and believes it has been beneficial to the airlines which, it is said, have taken every precaution to avoid stalling conditions in flight operations The Civil Aeronautics Board had not yet testified, and had "no comment." But in its report on the accident at the Chicago airport, CAB outlines the stalling characteristics of the DC-3

Certain heads of airlines who received the NACA report say that results of their own tests disagree with those of NACA They say that no fault was found with the DC-3 while it was giving the recent 17 months of no-accident performance They believe that it is "a good airplane" No equipment is perfect, they say, and they contend that probably no plane could show a better all around score in performance. Up to May 7, Douglas commercial transports had flown 2,061,236 hours and 239,232,980 miles. In the opinion of the airline operators none of the accidents has been due to stalling under power

There is no connection between CAB's new airworthiness requirement and the NACA report. The CAB ruling states that planes which cannot meet these performance specifications shall not be flown on the airlines after January 1, 1945 The requirement deals with performance on one engine, among other things

Export Airlines Loses Battle for Mail Fund But War Over U.S. Foreign-Flag Policy Goes On

Washington (AVIATION Bureau)—American Export Airlines lost an important battle to Pan American Airways when the Senate turned down an appropriation of $800,000 for AEA mail pay on its proposed New York-Lisbon route But though the battle was over, the old war about American flag competition on the seas will go on until the United States adopts a foreign service aviation policy

As debate on the air mail item drew near, both Export and Pan American frankly moved their lobbies out in the open and went to work on the Senate The vote was 44 to 35, a somewhat wider margin of victory than Pan American had expected The AEA route certificate had been approved by the Civil Aeronautics Board, over PAA's intervention

Export's executive vice president, John Slater, said after the vote that his company would go ahead with its three four-engined Sikorsky flying boats, in the hope that Congress will later honor the CAB's certificate with appropriations Also, the Company is going ahead with its proposed run from New Orleans to Panama.

Export officials felt that the vote had been the result of a partisan attack on the Administration, led by Sens. McCarran, Tydings, Bailey and others. State, Navy, and War Departments, the Post Office, CAB, and the Maritime Commission testified in favor of Export In the words of Export friends, Pan American Airways had succeeded in beating the Administration itself This, they hoped, would rouse the Administration to take a hand

Pan American officials said the case had been decided on its merits, that there was no partisanship They argued that the Senators had acted on the fact that the cost of adding a trip by Export would be half again as much as adding another trip by PAA Theory that more airplanes and more pilots, needed on the Atlantic for defense reasons, would be put on by a second operator, was unsound, they said, PAA can add all that are available to add

Furthermore, PAA contended, the Senate did not like the idea of giving the subsidy to Export, which, because of the neutrality law, already has a U.S flag steamship monopoly on the Atlantic They said that if AEA got the subsidy, PAA would have to quit, which would then give Export complete control of both sea and air

Pan American points out that Britain shifted from a one foreign-service line to a multiple line policy, and has now gone back to the single operator, because in PAA's opinion, foreign airlines are closely bound up with foreign policy, and too many cooks spoil the soup

CURTISS WRIGHT DIRECTORS made a flight in the Curtiss-Wright Transport in New York after the big ship's first cross-country trip L. to R.: President G W. Vaughan, Stuart R. Reed, W J Rich, E. S. Bloom, Myron B. Gordon, Board Chairman George Armsby Robert Earle, D. M. Sheaffer, John R. Dillon, H. G Hotchkiss, W. Hinckle Smith. The transport stayed several days at La Guardia Field.

Development Permitted On Four-Engine Ships

OPM has authorized Lockheed to go ahead on the design of its four-engine transport plane, the Constellation, and to build one ship of this design. Status of the Constellation has been doubtful for months as Army has insisted that technicians and manufacturing facilities cannot be spared from warplane production. Details of the Constellation have been a deep secret, but latest information makes it a 43-ton ship designed to use the 2,300 to 2,500-hp engine that Pratt & Whitney is trying to develop

Pan American has orders in for nine of the big Lockheeds—calling for 1942 delivery—and will presumably get the one to be built If the war is still going on when the ship is finished, Lockheed will doubtless have to content itself with lower powered engines Pan American's plans call for use of the Constellations in trans-oceanic service—an apparent shift from the flying boat philosophy

Work is apparently at a standstill on Douglas' DC-4s, the other main four-engine project. Reportedly, the airlines are not particularly anxious to get delivery on their DC-4 orders

Situation has somewhat clarified as to priorities on smaller equipment This year the airlines are to get 84 planes; a pool of four or five planes will be established to take care of replacements for accidents. Tentative allocations for next year are now being threshed out.

Meanwhile, military control over the lines was tightened a little when CAB announced a policy that any route certificates it grants, involving increases in service, will remain inactive until approved by the War Department

PAA to Singapore

On May 10 the first Pan American run from Manila to Singapore was completed, inaugurating a fortnightly schedule between the United States and British Malaya Singapore, great British Naval base, is the farthest point west on U S. Pacific airlines The new service is closely tied in with possible defense activities in the East.

PAA filed a new Alaska schedule with CAB, providing four schedules weekly between Seattle and Juneau. Time in the air, six hours. Time between Alaska and the Atlantic seaboard, 20 hours This service also has defense implications

The Company hopes to get a CAB certificate for a run between New Orleans, Merida and Guatamala, from which point it already holds a certificate to the Canal. American Export also has its application before CAB for this route It is believed that PAA hopes to operate the Lockheed 4-engined Constellation on this run, if and when it can get them.

Line Suspension Threat

CAA recently suspended all daylight airline operations in and out of San Diego until provision was made for improved traffic control facilities at Lindbergh Field The city is served by both United and Western Air, with several flights daily Heavy concentration of student activities of the Ryan School of Aeronautics was given as the reason for the suspension order Officials of the airlines and of the city quickly installed the required traffic control system and the suspension order was never actually executed Transport observers noted that this was the first such incident.

Trans-Canada Opens N. Y.-Toronto Service

One of the major carriers on the continent, Trans-Canada Airlines began operations between New York and Toronto May 10th with its first scheduled flight from LaGuardia Field Flying Lockheed Lodestars, the Canadian air line takes its place as the seventh line serving New York at the municipal airport. Two round trips daily are being operated, out at 8:30 A.M. and 9:15 P.M., and in at 2:30 A.M. and 1 P.M., the flight taking 2 hrs. 15 min. to Toronto as against 2 hrs. return

CAB Reports TWA Upset

Upon investigation of the TWA accident near Robertson, Mo., on January 23, 1941, CAB decides the cause was the action of the pilot in attempting a landing under adverse weather conditions, in disregard of the minimums prescribed by the CAA, and in maneuvering for such landing at a dangerously low altitude

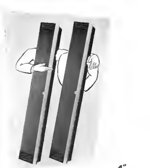
The Board recommends that the Administrator encourage the development of a continuously monitoring apparatus for ceiling light projectors, to give continuous observation of the height of clouds. Through proper setting of the instrument a change in the ceiling to some predetermined lower value would automatically set off an alarm When such a device is in operation, scud clouds over the field would be detected

AIR TRANSPORT INDICATOR

May 1, 1941

129.43

Which is the ratio of passenger-miles reported by the Air Transport Association for all domestic lines for April, 1941 to the figure for April, 1940 Total for the indicator has continued to rise from last year's low For the first four months of 1941 traffic stood at 320,377,773, revenue passenger miles—up 29.4 percent over April 1941 See Finance page for individual companies' traffic figures.



By Raymond Hoadley

First quarter profits of the airline and aircraft companies were lower than a year ago in many instances due to rising costs of operation for the transport concerns, and higher taxes plus smaller profits on United States government contracts in the case of the aircraft manufacturers. A glance at the earnings table on this page however shows two notable exceptions to the trend: the two large well-integrated companies, Curtiss-Wright Corp. and United Aircraft Corp., report a substantial increase in earnings as the result of a several fold step-up in deliveries of planes, engines and propellers. Others may be able to show somewhat similar gains in succeeding periods under the stimulus of rising volumes of production. Meanwhile higher taxes impend but the quarterly financial statements of many of the aviation companies have made liberal allowances for this inevitable development.

Domestic airlines had one of their best traffic months in April, passing the 100 million level in revenue passenger miles flown two months earlier than in 1940. Here are the preliminary statistics: revenue passenger mileage is estimated at close to 104,000,000 in April, as against 85,884,000 in March and 79,885,000 in April, last year. The gains totaled about 21 percent and 31 percent, respectively. April traffic brought the total for the first four months of 1941 to approximately 334 million revenue passenger miles, a gain of almost 28 percent over the 261 million miles flown in the corresponding four months of last year. The cumulative four months travel exceeded the volume for any year prior to 1935.

Higher taxes lie ahead for aviation and, as in 1940 when the excess profits taxes were first levied, there will be a few companies that probably will not feel the burden of these extra imposts this year. Increased corporate income taxes are usually set on the basis of the calendar year while several aviation companies, such as Douglas Aircraft, Vultee and Piper, end their fiscal years in a fall month. They will have to pay the extra taxes one year longer than other companies but that disadvantage will not occur until well into the future, for the new taxes will hang around for many years.

Domestic air transport lines will be frozen at their present size under a policy announcement by the Civil Aeronautics Board, but the fact that no new routes can be inaugurated during the emergency will not react unfavorably on the financial outlook of these companies. On the contrary, they will be able to consolidate recent expansion and get all their present routes on a paying basis without worrying about what their competitors are doing in the way of new extensions.

Vultee Aircraft has the widest geographical distribution around the country of any aviation company, with plants in California, Tennessee and Michigan. This fastest-growing of the smaller and more recently formed concerns anticipates substantial additions shortly to its unfilled order backlog which already is tenth in size among the plane makers.

National Aviation, an investment trust dealing solely in aviation stocks, recently sold large blocks of Pan American Airways and Canadian Colonial Airways while adding to its holdings of Boeing, Curtiss-Wright common, Chicago & Southern Air Lines, Bell Aircraft and United Air Lines.

Because of the sudden big demand for four-engine bombers in the present far-flung military operations of the British, more than usual attention is centered on Boeing deliveries, which totaled $9,038,000 in the first quarter of 1941 against $4,631,000 last year. It is assumed that a considerable portion of these shipments included Stearman training planes but flying fortress deliveries are said to be going forth at the rate of two or three a week. Boeing Aircraft of Canada had first quarter deliveries of $8,157 and a backlog of $9,503,000.

Higher dividend payments are in order this year if the declarations of the first two large companies taking dividend action in 1941 are any indication of the trend. United Aircraft will pay a $2 dividend to shareholders on June 16 while the Glenn L. Martin Company made a disbursement of $1.50 a share, as against total payments of only $2 in all of 1940. Other companies soon will be announcing semi-annual dividend action.

Piper Aircraft sales volume in the six months ended March 31 increased to almost $2,300,000, compared with slightly over $1,000,000 in the similar 1940 period, according to reliable estimates. Unfilled orders at the period's end stood just under $1,000,000. For the full fiscal year ending in September sales are expected to total 6,000 planes, roughly, as compared with about 3,000 in the preceding year.

Breeze Corporation's April sales crossed the million dollar mark for the first time in April and were four times larger than a year ago. Sales through May are expected to top the $4,500,000 shipments made in 1940. The current backlog amounts to around $12,000,000.

Taylorcraft output is said to be running approximately twenty-five planes a week—four times than that of a year ago. An order was recently received from Peru for ten training planes to be used as the nucleus of a civilian pilot training program there.

Industry Backlog

New orders for military aircraft are running behind deliveries for the first time since the defense program began. Current unfilled orders amount to $3,988,000,000, four times greater than a year ago but showing a slight decline from the record four billion reported a month ago. However, additional orders still to be placed should raise aircraft backlogs to successive new high levels as planes are scheduled for production on into 1943 that will have an estimated value of nine billion dollars. The United States is now producing better than 17,000 planes annually and will be up to a 30,000 yearly basis by early fall. In the first quarter of 1941 the domestic output approximated $225,000,000 while exports totaled $124,000,000. Meanwhile aircraft plans projected under the lease-lend and supplemental defense program will call for further plant expansion and the addition of at least one more automobile company into the ranks of the primary aircraft manufacturers. The following table gives the latest approximate unfilled orders of twenty-six primary producers:

Allison	$200,000,000
Aviation Corp	16,000,000
Beech	22,900,000
Bell	62,500,000
Boeing	188,600,000
Brewster	100,000,000
Buick	91,200,000
Cessna	25,000,000
Consolidated	610,000,000
Continental	35,000,000
Curtiss-Wright	712,000,000
Douglas	400,000,000
Fairchild	15,000,000
Ford	122,000,000
Grumman	52,000,000
Lockheed*	188,000,000
Martin	285,000,000
N. American	190,000,000
Northrop	30,000,000
Packard	217,400,000
Republic	60,000,000
Ryan	10,000,000
Studebaker	20,000,000
United Aircraft	406,000,000
Vega	74,000,000
Vultee	65,000,000
	$3,066,300,000

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* Does not include subcontract to Vega

Current Earnings Reports

Company	Period	Net Profits 1941	Net Profits 1940	Profits per share 1941	Profits per share 1940	Sales 1941	Sales 1940
Aero Supply	3 mos. Mar 31	$177,704	$115,235	$0.43	$0.26	$1,578,865	$877,306
American Airlines	3 mos. Mar 31	71,060	304,053	0.05	0.86	4,733,472	3,862,157
Borg Warner	3 mos. Mar 31	2,367,597	1,475,218	1.01	0.63		
Curtiss-Wright	3 mos. Mar 31	4,886,020	2,414,100	0.58	0.24		
Douglas	3 mos. Feb 28	1,816,535	1,804,877	3.03	3.00	17,929,511	12,902,904
Eastern Air	3 mos. Mar 31	486,483	511,578	0.85	0.89	3,574,707	2,828,853
Eaton Mfg. Co	3 mos. Mar 31	582,712	637,878	1.38	1.33		
Fairchild Aviation	3 mos. Mar 31	126,736	209,012	0.30	0.62		
Hayes Mfg. Co	3 mos. Mar 31	27,863	L 78,963	0.04			
Martin	3 mos. Mar 31	1,861,790	2,162,670	1.70	1.97	17,063,147	6,011,393
Square D Co	3 mos. Mar 31	734,179	400,858	1.75	0.85		
Thompson Products	3 mos. Mar 31	861,202	522,166	1.68	1.65	6,801,801	5,486,370
TWA	6 mos. Mar 31	L 987,968	L 234,870				
United Aircraft	3 mos. Mar 31	4,806,495	2,380,929	1.80	0.85	54,881,547	16,806,622
United Airc. Products	3 mos. Mar 31	169,757	94,223			1,533,151	543,840

L — Net Loss

Recent Awards

War Department

Curtiss-Wright Corp., Buffalo N Y $168 868 for maintenance parts for planes
Aviation Mfg Corp., Williamsport Penna $ 2,149 for parts for engines
Cleveland Pneumatic Tool Co. Cleveland Ohio $150 000 for oil pumps high pressure
Sharpsville Steel Fabricators Inc Sharpsville Penna., $166,480 for cylindrical tanks
Teleflex Metal Hose Co., Newark N J $257 765 for manifold assemblies
Bendix Aviation Corp. Sidney, N Y $126 000 for manifold assemblies
Aluminum Co. of America Pittsburgh Pa., $283 970 for aluminum alloy
Wright Aeronautical Corp. Paterson N J $110 760 for parts for engines
Wright Aeronautical Corp. Paterson N J $425 153 for aeronautical engines
Bendix Aviation Corp., Bendix N J $252 545 for maintenance parts for instruments
Air Associates, Inc Bendix N J $181 620 for electric motors
Continental Motors Corp., Muskegon Mich $590 942 for engine maintenance parts
United Aircraft Corp. East Hartford Conn $4 781 107 for engine overhaul and parts
Curtiss-Wright Corp., Buffalo New York $13 360 562 for airplanes and spare parts
Douglas Aircraft Co Inc Santa Monica Calif $43 521 300 for airplanes and parts
Boeing Aircraft Co Seattle Washington $ 7 201 352 for airplanes and parts
United Aircraft Corp. East Hartford Conn $1 749 439 for aircraft engines
Goodyear Aircraft Corp Akron, Ohio $1 653 813 for educational order for entire wings
Goodyear Tire and Rubber Co Akron Ohio $882 518 for wheel and brake assemblies
Edgewater Steel Co. Pittsburgh Penna $158 492 for adapter assemblies
Fairchild Aviation Corp Jamaica New York $472 479 for computer assemblies
Sperry Gyroscope Co. Inc, Brooklyn N Y $ 16 000 for instruments.
Chandler-Evans Corp South Meriden Conn $132 610 for maintenance parts.
Pump Engineering Service Corp Cleveland Ohio $470 265 for fuel and vacuum pumps
Curtiss-Wright Corp Caldwell N J $147 434 for blade assemblies
Wright Aeronautical Corp. Paterson N J $149 512 for aeronautical engines
Square D Company Elmhurst N Y $217 905 for oil meters
General Motors Corp Dayton Ohio $992 289 for strut assemblies
Standard Steel Works North Kansas City Mo $624 332 for trailers and dollies
Wright Aeronautical Corp., Paterson N J $661 048 for parts for aeronautical engines
Ford Motor Co, Dearborn Mich $3 415 508 for educational order for airframes
Sperry Gyroscope Co, Brooklyn N Y $1 999 265 for indicator and controller assemblies
Sperry Gyroscope Co. Inc., Brooklyn N Y $435 160 for automatic pilots.

Navy Department

None

Glenn L. Martin Co. has been awarded a $24,275,000 plant expansion contract by the War Department It is reported that this contract will be followed by a plane order somewhere in the neighborhood of $100,000,000

Aeronca Aircraft Middletown, Ohio, plans to produce 2,000 planes this year, more than twice as many as in 1940. March output was 400 percent above the corresponding month last year. An expansion program calls for a 35 percent increase in plant facilities and 300 additional workers by the end of the year

A New Plane To Make Every Man a Pilot

A startling new two-control airplane placarded by the C.A.A. as "Spin-Proof"

TAKE-OFF in less than 300 feet, landing run less than 100, spin-proof, aileron control in stalls and every turn a perfect one are a few of the outstanding characteristics of this new two passenger light plane Built by the General Aircraft Corporation of Lowell Mass., this unusual ship is designed for pure, two control flight in that there are no rudders, but in their place fixed vertical fins that eliminate side slip

With this simplified control almost any person can familiarize himself with the relation between the elevators and ailerons in about 15 minutes flying time and become practically an experienced pilot in handling this ship within two hours Climbing into the ship one of the first things noticed is the lack of rudder controls and the floor being bare except for the wheel brake near the pilot's right foot The control wheel is conventional and embodies all of the control of the ship With its tricycle landing gear, the visibility is excellent and is better than in most automobiles

Preparing for take-off, the flaps are lowered to the 30 degree position by raising a lever, located between the side-by-side seats to the first notch For quicker take-offs from a short field the flap is lowered to the position normally used for landing (45 degrees) Using these flaps for take off and during the first few minutes of flying gives the ship very good climbing ability. When once in the air the excellent flying characteristics of the ship are immediately noticeable. With the control column pulled full back, and the plane in a power-on or power-off stall, a turn of the wheel to the right or left immediately has response by tipping the ship In making turns the pilot moves the control wheel to the right or left and has only to watch the position of the nose to make a level turn The plane has been designed so that the steepness of the turn is controlled by the ailerons, making precision turns very easy

Coming in for a landing the pilot sets the flaps at the 45 degree position and with this he can descend at a very steep angle The actual landing can be made with any one of the three wheels touching first, as the position of the center of gravity tends to right the plane and bring the other two wheels in contact with the ground Landings can be made directly on the nose wheel, which has been designed to withstand the full weight of the ship Once on the ground a very sudden stop can be made by applying the wheel brakes, nosing over being resisted by the nose wheel.

Construction

Named the "Skyfarer" the ship was designed by Prof Otto C Koppen of the Massachusetts Institute of Technology Throughout it has been built for simple manufacture and easy maintenance work The fuselage, outside of the engine mount and center truss which are welded steel tubing, is assembled by means of Elastic Stop Nuts, the longerons and cross braces being aluminum alloy channels Replacing a

(Turn to page 186)

OPERATORS CORNER

SOARING HITS A NEW HIGH

A report on the Fourth Annual Western Gliding and Soaring Championship Meet.

Pacific Coast soaring literally hit a new all-time high with the staging of the Fourth Annual Western Gliding and Soaring Championship meet at Arvin, Calif, April 12-27th. Not only were all previous records for flights made and spectators in attendance broken, but the present American altitude record was exceeded by a wide margin. Unfortunately, the barograph on this particular flight had not been properly set and so no official record can be credited

Originally scheduled to run for a period of one week, the meet was extended over two weeks on account of bad weather. Record crowds responded to the extension and as a result the meet was a financial success, with substantial cash awards being made to all leading pilots participating

This year a new Western Soaring Champion was crowned and, appropriately enough, top honors went to the two-place "Baby Bomber" sailplane designed, built, and flown by Alan R. Essery, of San Diego Neither Woody Brown, last year's champion, nor John Robinson, national champion, were on hand to defend their laurels Essery won by virtue of a 25 per cent bonus awarded two-place sailplanes carrying a passenger, as he was substantially surpassed by Howard Morrison, flying a Bowlus Baby Albatross, on a basis of "earned" points alone Third place went to Harold Huber, piloting the Super Albatross high performance mid-wing sailplane, and fourth place to Henry Stiglmeier, with a Bowlus Baby

More than 30 pilots participated in the meet, flying a total of 26 different sailplanes While there was a preponderance of Bowlus planes on hand, the Briegleb BG-6 was also well represented Notable planes present included the Aero I.T I all-metal sailplane which won the AVIATION magazine design trophy at the 1940 national meet, and a very commendable new side by side two-place mid wing designed and built by Volmer Jensen

Total flights during the meet were 324 with a total flying time of 246 hr 51 min, and a distance flown cross-country in accredited flights of 2574 miles, or equal to a full trans-continental trip without benefit of engine power

A number of notable flights were made during the Arvin meet One of the most daring was that by young Richard Johnson, who flew his Bowlus Baby Albatross across the treacherous Ridge Route mountains a distance of 65 miles to the town of Saugus. This is the first time any soaring pilot has ever negotiated the Ridge Route which is a barrier of rugged mountains ranging 5-8,000 ft in height and with almost no intermediate landing areas other than the highway

The American goal and return distance record was broken both for single and two place sailplanes Howard Morrison first made the flight to Maricopa and return, a distance one way of 42 miles, and the trip was later negotiated by Alan Essery with a passenger. Numerous flights of 40-50 miles were made in all directions. Longest duration flight was made by Richard Johnson for a time of 5½ hrs.

Outstanding flight of the meet was turned in by Henry Stiglmeier in a Bowlus Baby Albatross on a day when soaring conditions were poor Stiglmeier was ready for launching when a small thunder storm swept over the hill He took off and was soon sucked into the cloud, flying blind for 75 minutes and reaching an altitude of more than 20,000 ft above the point of take off The barograph needle had been set too low and ran off the chart at 16,800 ft so the flight does not go into the records. Although Stiglmeier opened his spoilers to hold down the rate of climb he found the rate of climb showing 30 ft per second up Soon all of his instruments except the turn and bank indicator iced up and about half an inch of ice formed on the leading edges of wings and struts His controls froze in the spiral condition and ice formed on his cockpit enclosure. As he had no oxygen equipment and was not warmly dressed he suffered from both cold and altitude Flying by feel, ear, and with the help of his turn and bank, which continued to function, Stiglmeier managed to spiral back down through the storm and make a safe landing, the ice having been dissipated when he dropped below the 15,000 ft level

The Arvin meet was jointly sponsored by the Southern California Soaring Association, Arvin Boosters Club, and Kern County Chamber of Commerce Field activities were in charge of Jay Buxton, pioneer soaring enthusiast

ALAN R ESSERY, new Western Soaring Champion, taking off on a winch tow launching in his own designed two place glider

Medal of Month Club

The Medal of the Month Club has been organized recently by Miss Felicity Burenelli, 15 West 67 St, N Y, City Each month a new medal is designed by a famous sculptor and small bronze replicas are sent to members The first series is on aviation, and medals already designed are of the Wright brothers, Capt. Edwin Musick and Amelia Earhart. Other famous aviation personalities will be included

The set of six aviation medals cost $4 in the Collectors' series and $2 in the children's series. With the medals comes a board for mounting them and a pamphlet describing the person concerned. Medals are 1½ in. in size and are very attractive

"I Wanted Wings" Contest

Some 586 Piper dealers are cooperating with their local movie theatres this month in a contest sponsored by Paramount Pictures to publicize "I Wanted Wings." Contest is run for individuals over 16 years of age who write a 60 word essay on "Why I want to fly" Local judges decide the winner, who gets a free eight hour course, given by the Piper dealer. National winner gets a free Cub, donated by the factory

The contest, conceived by Norman Warren, N Y advertising agency, seems to be a natural By giving free eight hours of time, the local Piper dealer gets a vast amount of local advertising, as the moving picture house and the local newspaper are getting behind the contest in a big way Hundreds of people in every community have their attention drawn to the Piper dealer and to the local airport Paramount is also distributing another film called, "Power Dive" which features a Piper Cub This movie also helps to sponsor the contest

Broadening their organization to keep pace with rapid expansion of private flying, Ronnie Shillington, president of the Aviation Credit Corporation of St. Louis announces opening of branch offices in Dallas and Los Angeles The new Dallas branch office is in charge of Dan Regan, long active in aircraft financing, and is located on the ground floor of the Love Field Administration Building, directly at the end of the passenger ramp. Regan's slogan is "Taxi right up to our office, and when you're ready to leave, we'll twist the prop for you"

The Los Angeles branch, on the third floor of the control tower building at Van Nuys Metropolitan Airport, is in charge of Tom E, Collins, vice-president of the Aviation Credit Corp

Under the expanded program of Aviation Credit Corporation a major activity is financing the operations of CAA flight instruction contractors

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BENDIX RADIO NEWS

BENDIX RADIO

JUNE 1941 Published by BENDIX RADIO CORPORATION, Baltimore, Md. Cable Address BENR

OUTSTANDING CONSOLIDATED SHIPS EQUIPPED WITH BENDIX RADIO

Destined for Great Britain, this Consolidated Model 32 four motored long range bomber is one of the many such ships already delivered or on order for use by the Royal Air Force abroad This bomber is also being manufactured for the U S. Army Air Corps These giant tricycle type bombers are equipped with Bendix Radio Receivers, Transmitters and Compasses as standard equipment for British models

Richard Archbold's Consolidated - Built "Guba" used by the American Museum of Natural History's expedition into New Guinea. Completely equipped by Bendix it set new standards of reliable long distance communication during its 13 months of service, under most severe tropical conditions

Radio Control Position of the "Guba" showing the Bendix RA 1 Receivers, Transmitters, Interphone and associated Equipment From this position the "Guba" maintained contact with the world while buried in tropical New Guinea, offering further proof of the dependability of Bendix Radio

FLASH!!!

Chicago & Southern, China National and Inter-Island Airlines purchase Bendix MN-31 Automatic Radio Compasses.

Bendix Receivers, Transmitters Compasses on Consolidated Military, Commercial, Private Craft

First Military Plane to be flight-delivered across the Atlantic was th Consolidated Model 28 Over-Ocean Patrol Bomber. Delivery w made before the outbreak of the present hostilities Like many oth Consolidated military naval and commercial aircraft built for th United States, Britain and other countries, it is Bendix Equipped.

American Export's Consolidated Model 28 pioneer ship of the li which served as a "flying laboratory" for radio and navigatio equipment in establishing the present trans-Atlantic route from N York to Europe Completely Radio-Equipped by Bendix this pla consistently maintained 2 way communication with New York wh on the water in European ports setting a new standard of efficien in Radio Communication

BENDIX RADIO—STANDARD FOR THE AVIATION INDUSTRY

The Birdmen's Perch

This month, customers, the Perch inaugurates a new policy—rougher and tougher problems—Brain Twisters that will keep you awake nights! The first one of the new series appears below. Go to it, men!

Major Al Williams, alias "Tattered Wing Tips,"
Gulf Aviation Products Manager, Gulf Bldg., Pittsburgh, Pa.

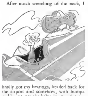
FUNNYBONER DEPT.

Dear Major

Taking my old OX Traveler biplane up for a spin one day I decided to try a loop and see what the danged things felt like.

I was zipping along at ninety and slowly eased back on the stick to make a beautiful loop for all the countryside to see. Imagine my chagrin when she fell out on top and after a turn or two, came out of the spin. Well, I decided then that we needed more speed, so I shoved the nose down and watched the air speed climb up. Then when I thought she had enough speed, I yanked back on the stick, like a dope.

I felt as though my ears were sticking out of my side pants pockets, when all of a sudden there was a crash and I felt myself shoved violently to the bottom of the seat. What followed I'll never know, but I found myself cruising along right side up, sitting on the floor with nothing between but the 'chute!



After much stretching of the neck, I finally got my bearings, headed back for the airport and somehow, with bumps and bangs, got the baby down without a mishap. I rolled up to the hangar with nothing but my head showing and proceeded to investigate the damage. I almost passed out when I saw the seat was just hanging by a thin wire and knew that if I had fallen out on the top of the loop I'd never have thought of the seat being still strapped to me and would have pulled the rip cord in vain, for the 'chute couldn't have opened.

That was my last loop.

Very truly,

Eugene W. Beatty
Parkersburg, W. Va.

THIS MONTH'S BRAIN TWISTER

Miss Jerrie Cunningham, of Atlanta, Ga., sends this one in:

My plane ran out of gas in the middle of a desert but near by was a gasoline dealer who had only 8 gallons left. He promised me half of what he had, provided I could measure accurately the 4 gallons.

The only empty containers he had were a 5 gallon and a 3 gallon measure, and of course the full 8 gallon measure. How did I successfully measure the even 4 gallons?

TAKE A TIP FROM A SAILOR

Ever been around a boat yard when they haul the boats out, and been amazed at the amount of weed and barnacles below the water line?

To combat these fouling growths, some sailors sail their boats up a convenient river where practically no growth occurs below the water line.

The secret lies in the difference between salt and fresh water. *Fresh water just doesn't contain* the organisms that are responsible for heavy growths of weeds and barnacles.

It will pay you to remember this sailor's trick the next time you buy oil for your engine. For though you can't tell by looking at the oil, there are some oils that contain less of the things that start trouble than others. And Gulfpride is outstanding in this respect! Because, by means of the famous Alchlor Process, we've *taken out* more of the carbon and sludge formers!

THIS MONTH'S WHOPPER

Dear Major:

When I reads ALL SLIDE RULES BARRED I figures you just spelled "bared" with an extry "r" not bein' as good at spellin' as I am, so I pulls my slipstick out of the case and does it get hot tryin' to figure Max Conklin's speed puzzle.

My buddy, a baseball player, says they ain't no slide rules except that you gotta touch the bag or the plate and slide with the spikes ahead.

Then I shows him the slipstick, which he calls a chestnut ruler, one length for buyin' and one length for sellin'. Crooked, says he.

Well, Max takes off an' does 90 miles per for the first mile. How fast must he fly the second mile to average 180 for the two miles? My buddy, the baseball player, being under the compression that he can figure it out with a pencil, says it should be figured in collapsed time, reducin' it to miles per minute or seconds as a common denominator.

He claims that doin' 90 miles an hour lets you do a mile in 45 seconds, while flyin' 180 miles an hour you does a mile in 20 seconds or two miles in 40 seconds. So he says if you took 45 seconds to do the first mile, and you should have done the two miles in 40 seconds, you're already 5 seconds overdue, so no can do.

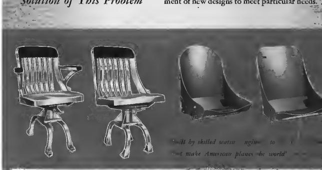
Me, I'm more of a engineer, and am still tryin' to figure it out on the slipstick. Will let you know when I get the CORRECT answer. Don't pay him no mind, but just in case he's right, remember, I helped him!

Yours truly,

Erwin E. Schwalt
Atlantic City Aero Club

Gulf Oil Corporation and Gulf Refining Company . . . makers of

GULF
GULF AVIATION PRODUCTS



No Ersatz

(Continued from page 45)

meager instrument equipment on Nazi planes, this ship has a very fine set of instruments and complete radio equipment. One item of instrument equipment is well in advance of our current practice, and that is the remotely mounted compass, which is situated back in the tail of the machine with an indicating dial on the pilot's instrument board This feature doubtless helps to compensate the compass for large masses of steel represented by gun and engine installations Radio equipment appears to be of the highest type, and the quality of German precision instruments is well known The pilot is provided with an artificial horizon in addition to the turn and bank indicator Tachometers, temperature and pressure gages are provided for both engines And the pilot has a sensitive rate of climb instrument in addition to standard altimeter and air speed indicators

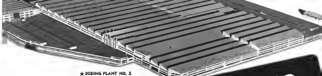
Installation of equipment and accessories and the general handling of plumbing and wiring throughout the machine is most praiseworthy Everything is accessible to a degree which at least matches current American practice. All hydraulic lines are coded by color and direction of flow is indicated with arrows Quickly detachable connectors are provided in all cases Where items of equipment are not readily accessible from within the plane they are provided with large doors for easy accessibility from outside. The general attention paid to serviceability is well illustrated by the engine and wing mountings The wings are each made in a single panel, attached to the fuselage structure by four fittings These fittings are themselves easily accessible and simple. It would probably be but a few minutes work for a trained crew to remove both wings When the wings are removed there is exposed against the outside of the fuselage a substantial portion of the control plumbing and wiring This wiring, incidentally, is shielded throughout the plane, but no conduit is used. Shielded wires are simply hung in place along the structure by means of simple clips, resulting in complete accessibility for maintenance work Throughout, simplified maintenance has been stressed.

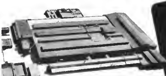
The engines are mounted on the conventional forged magnesium alloy arms which are standard with most German planes These free the engine compartment of complex structural members and provide for easy accessibility to all parts of the engine requiring routine servicing. Service doors in the engine cowl make it possible for the mechanic to reach all spark plugs or injection pump parts instantly

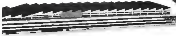
Detailed structural design throughout the plane appears to have been dictated chiefly from a production standpoint. There is every evidence that this machine is assembled from component parts produced in a wide variety of shops. In fact it may well be that not all planes of this model are identical, for there is such a wide variation in the use of castings, forgings, welded fittings, etc, that it is conceivable that one plane might have a forged part of magnesium where another would have a welded steel tube or riveted aluminum alloy part for the same purpose. We do not know that this is the case, but we do know that the plane has been designed for rapid final assembly from component parts which might vary considerably in tolerances. This is illustrated in various ways. The wing root and tail fairings, for example, are attached by means of screws and washers in such a way that large attachment holes in fairing parts, plus the wide washers, make up for any variance from tolerances The wing fittings are of special interest. Since the wing is of monospar design there are but two main attachment fittings, with two locating and stabilizing fittings fore and aft The lower main fitting is a pin joint about which the wing may be swung vertically for dihedral adjustment, which is accomplished by two lock nuts on the threaded bolt projecting into the upper main fuselage fitting This fitting has appreciable "slop" or looseness laterally which permits the wing incidence to be set at the fore and aft locating fittings These have location blocks with horizontal serrations, permitting considerable horizontal or vertical adjustment before bolting the blocks solidly in place. This same feature is found in many places throughout the plane where universal joints, or ball and socket joints provide for quick connections of parts without concern for close adjustment.

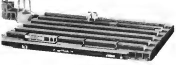
The wing is made with a large single main spar "A", which is chiefly a shear web at the maximum lift point, with a false spar "B" toward the trailing edge while the nose serves as a front spar member The main spar is a single heavy plate of aluminum alloy with simple angle cap strips riveted at top and bottom. The main tension fitting "C" is of pin-hinge type and is probably attached to the fuselage attachment fitting first, then the wing is swung up around this as a fulcrum to allow the upper compression fitting "D", of bolt type, to slip into place "E" and "F" are the fore and aft fuselage attachment fittings

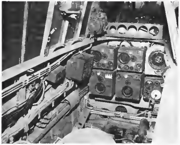
Removal of the wing panel exposes electrical control panel at the left, pneumatic and hydraulic quick detachable line connections at upper right and flap and aileron controls Wing is attached at four points Two main connections are tension and compression fittings at single main spar, with fore and aft locating fittings Spar tension fitting is shown in lower center and consists of a single pin hinge which permits wing to be adjusted for dihedral. This adjustment is made with upper spar fitting consisting of a long threaded bolt on the wing spar which is projected into the fuselage fitting hole shown in upper center and is located and held there by two heavy lock nuts











The center compartment is for radio equipment and cannon loading under the floor. Note shielded wiring hung on side of the fuselage exposed plumbing and complete radio equipment.

This is also true of the engine mount attachment, which by means of universal joint connections allows a wide variance without causing strain or misalignment.

Nowhere in the construction of the 110 is there any evidence of hasty workmanship, “ersatz’ ” materials, or substitution of any kind. Steel, aluminum, magnesium are all used in abundance, and there is quite a bit of rubber in the plane whether synthetic or natural. The tires, interestingly enough, are marked Made in Germany in three languages, including English, which may indicate they were originally manufactured for export. Steel is used for canopy framing, undercarriage parts, main spar structures across the fuselage and in numerous smaller applications. Magnesium forgings are used for various control arms, engine mount arms, etc. The bulk of the structure of both the fuselage and wings is of aluminum alloy sheet material. Structural design runs a little closer to the true monocoque than with most American skin-stressed planes. The skin of fuselage and wings is of comparatively heavy gage and the structure is simplified considerably. The result is that the exterior surfaces are quite rigid producing smooth contours which are probably of high aerodynamic efficiency as well as weather and wear resistant.

The fuselage construction is particularly interesting partially because it is not apparent how the skin sections are formed. The fuselage is constructed in two halves, split along the top and bottom centerline. Sections run laterally rather than longitudinally. Forming rings largely were eliminated by forming a joggle and an open “C” flange at one edge of each skin section. This provides for flush joints and gives sufficient lateral stiffening without added internal support. Longitudinal stiffeners are rolled or drawn channel sections extending fore and aft through cutouts in the open flanges mentioned above. Longeron members running past the cockpit section are apparently one-piece stampings of heavy sheet material. Throughout the plane every effort has been made to reduce the number of parts used, relying on simpler, larger, and heavier parts to carry the load.

For example, the wing is of extremely simple construction of monospar type. Actually the wing shell is the spar, with a single shear web installed at the point approximating center of lift. This web is a solid sheet which is riveted to simple angle flanges along top and bottom to form an “I” beam. These flanges, in turn, are riveted directly to the wing skin. This skin is laid on in large pieces extending fore and aft rather than spanwise. Ribs are not closely spaced and are built up of riveted sections. Spanwise skin stiffeners are also relatively few, since the thickness of the skin reduces the requirement for stiffening members.

One item of interest, and not fully explained to date, is the quick releasable tail cone. This part is of clam shell construction hung to the fuselage stern by three pins, one of which may be tripped by a cable to the cockpit. When the pin is tripped this cone flies off, and open, since it is hinged at the rear. It is surmised that a collapsible flotation bag, or life raft, is carried in this way for protection against water landings. An external retaining wire runs from the cockpit to the tail cone, probably as a means of hauling in the raft after a forced landing.

Engine cooling radiators are very cleanly installed. The oil cooler is in the nose of the engine nacelle, but each engine coolant radiator is located in the wing near the trailing edge, between the main spar and the flap. In this position the minimum drag is probably achieved for cooling flow obtained. Exhaust air can be controlled by means of an adjustable flap. Engine intake air is taken through a duct in the leading edge which is smoothly cowled and vaned for efficient air flow.

Engines are of Daimler-Benz type of 1,150 hp., and are supercharged. Fuel is injected into the cylinders but ignition is by conventional Bosch magnetos and two spark plugs per cylinder. Neither engine has been dis-assembled, but the external impression is one of extreme ruggedness and simplicity. V.D.M. propellers, of three-blade type, are electromechanically controllable to full-feathering position.

Canvas shields, with zipper fastenings, protect a number of parts of the plane from dust and water. This is the case in the cockpit, which is well sealed against wind or air leakage. But there is no apparent provision for forced ventilation or heating of the crew's compartment. Nor is there any de-icer equipment provided on wings or propellers, nor any windshield wiper. Also the engine air intake looks susceptible to icing.

Wing flaps and the retractable landing gear appear to be hydraulically operated with pneumatic emergency control. The landing gear is simple and rugged, retracting the wheel straight back up into a wheel well in each engine nacelle.

Interestingly enough, engine exhaust stacks are simple elbows used to deflect the exhaust away from the engine radiator, and with no more than a limited attempt to employ the jet propulsion effect utilized by the British.

The engines on S9CK are rather oily, though this may be the result of the forced landing. In any case the machine shows signs of hard service in many ways and it is to be surmised that this particular plane had done a great deal of military flying of one kind or another before it was finally brought down in England, affording our designers a first-hand study.

Selig Altschul

(Continued from page 100)

Come what may, the fact remains that the air transport industry has strong growth characteristics and is clearly among the most favored in the post-war period that is bound to follow. It is this factor that influences many sophisticated investors to maintain an interest in air line equities for fear of losing a position at the unknown turning point.

Rising labor costs have developed as an important factor in the earnings outlook for the aircraft industry. As such a large percentage of the aircraft manufacturer's selling price is represented by labor disbursements, such costs are of vital significance. An insurance company study recently showed that the average U. S. aircraft builder pays 28 percent of his selling price for direct labor, another 12 percent for indirect labor—supervision, designing, testing, etc.,—and 39 percent for parts and materials. But parts and materials thus acquired, consisting of engines, instruments, accessories and finished parts, themselves average from 25 to 30 percent direct labor costs plus additional indirect wages. (For example, the average airplane motor requires 4,000 hr. of direct labor, and military planes average two motors each. The price of the iron and steel used by the engine manufacturer, in turn, is 35 percent direct labor, while going back further, the iron ore purchased by the steel mills is 36 percent direct labor.)

Summarized, accumulated direct manufacturing wages total 47 percent of the selling price of the average plane. Indirect labor costs (items involved in designing, supervision, engineering, sales and management, etc.) accumulate another 19 percent of the price, making a total of *66 percent of the selling price of the finished aircraft which has gone for wages.* Actual material, when labor is extracted, boils down to a net of 15 percent. All other items, including taxes, depreciation, profit, interest, etc., account for 19 percent of the price. Such analysis indicates that the aircraft group probably pays more in labor costs in proportion to its gross sales than any other major industry.

Fortunately for the aircraft builders, some relief may be obtainable from the evident squeeze occasioned by rising labor costs. Starting July 1, the Army Air Corps is scheduled to examine contracts containing price adjustment clauses so that government payments to aircraft manufacturers may be revised upwards. Not all defense contracts, however, contain these so called escalator clauses, nor are such clauses uniform in all cases. Reports indicate that work is underway to an overall revision which is expected to result in a standard form acceptable for use by both the War and Navy Departments on most of their future contracts.

How well paid are aircraft workers? This has become an important issue in recent months. The Department of Labor best answers this question in its February, 1941, figures showing average earnings for various industrial classifications. For the month indicated, aircraft workers averaged $35.20 per week and 78.4 c. per hour, an increase of 21.7 percent and 7.2 percent respectively over February, 1940. All manufacturing industries averaged but $28.56 per week and 69.2 c. per hour for February, 1941. The broad transportation industry group, however, showed $38.44 per week and 91.6 c. per hour. While exceeded in weekly wage rates by the automobile and shipbuilding groups, the aircraft industry topped the average paid to the railroad car and locomotive workers. The trend of aircraft wage rates, moreover, definitely show that this group is making constant progress in increasing its earnings.

Gains by the aircraft worker are being made on other fronts as well. A new contract signed by a CIO group with Brewster, among other things, provided for the first check-off in the aviation industry. The nature of other gains are also impressive in view of the late organization drive started by the CIO. The union had already obtained a closed-shop in a previous contract and provision has now been made to recognize it as the representative of employees in any new plant to be opened by the company. The company further agreed to submit for union approval the list of employees for which draft deferments would be sought. While such concessions appear to give organized labor important gains, they also invest the unions with a greater responsibility and have a tendency to make for a certain rigidity in the aircraft industry which in turn may make difficult the adjustment processes in the transition to a peace-time economy.

Barron's Stock Averages

	Aircraft	*Air Transport*	*50 Stocks*
May 2, 1941	33.90	18.94	66.0
April 25, 1941	33.68	19.66	67
April 17, 1941	32.68	19.78	67
April 10, 1941	33.88	20.28	69
May 3, 1940	46.90	32.97	84

The ever-present problem of taxes bulk large in the future outlook of the aircraft industry and individual reports must be examined carefully in order to obtain a true picture of earning power. This is best illustrated in the initial quarterly statements currently being released. For example, the Glenn L. Martin Co. for the 1941 first quarter showed a net profit of $1,861,790 or $1.70 per share as compared to $2,162,670 and $1.97 per share for the like 1940 period. However, current earnings are after an allowance of $2,500,000 for "contingencies and additional taxes"—equivalent to $2.28 per share. Such additional reserve is after provision of $1,467,000 for normal federal income taxes.

United Aircraft Corp., after an allowance of about 29 percent of available net income for normal taxes, also made provision for $4,751,020 (equivalent to $1.80 per share) for excess profits taxes. Even after this deduction, the company's first quarter earnings amounted to $4,806,496, or $1.80 per share.

By contrast, Douglas Aircraft, while providing for normal income taxes did not make any provision whatsoever for excess profits taxes for its first quarter. With its fiscal period beginning later in the year than Jan. 1—Douglas may be expected to delay the full impact of excess profit taxes. It is difficult to see, however, how Douglas can avoid such payments and it appears likely that later this year, provision will have to be made for a charge that should have been properly allocated to the first quarter. Even with the benefit of this accounting adjustment, Douglas earnings for the quarter ended Feb. 29, 1941, totaled $1,819,535 or $3.03 per share.

The contrasting policy pertaining to tax adjustments clearly shows the uncertainty prevailing as to the ultimate form the final tax bill will assume. It is certain, however, that higher levies are coming and must be taken into consideration.

The fact remains that current earnings as reported by the aircraft builders are distorted and will continue to be so until final adjustments are made. This not only applies to tax charges but also to depreciation and amortization, items occasioned by the expansion program. It is not inconceivable that there will be differing views as to proper charges between company officials on the one hand and the Treasury Department and other agencies on the other. In fact, reports indicate that one billion dollars in new armament contracts are now being held up primarily because the NDC wants to be certain that nothing in these contracts will permit private capital to put into prices more than the normal, legal charge for depreciation of plants erected and useful for wartime production only.

Bell Production

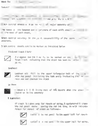
(*Continued from page 49*)

that nothing has been incorporated in the airplane which would be impossible to build in the shop, however complete control is left in the hands of the engineering department

It has been this pre-production designing of the Airacobra that has led to its being one of the most easily produced airplanes However, the accomplishment of this ease of production was brought about by introducing the new line of thinking in transferring the engineering design on paper into the physical parts of the airplane The key of this new idea lay in making every single part of the ship in the mold loft first The introduction of this 100 percent lofting came after the design of the Airacobra was well under way and, in fact, 30 percent of the design of the ship was scrapped in order to introduce the new idea.

The Airacobra was broken down into five primary units and then each of these divided into their individual parts Then, instead of lofting just the larger parts of each unit and tooling the rest, every single part was lofted individually and this included machined parts and fittings In so doing an inexperienced man in the shop can take two parts and make them match perfectly because not only has the outline of the design been matched, but all of the holes for assembly are assured of being in their correct position In doing this each part has been drilled with pilot holes which the workman uses for matching and holds together with clips during production Doing this lofting design has eliminated 30 percent of the fixtures heretofore needed for production and has also aided in speeding up production because with the lack of these fixtures the work is left out in the open where the workmen can get at it

A record is kept at each assembly station rack of the number of each part needed at that station. The solid squares show those parts assembled while the shaded ones are the number on hand.

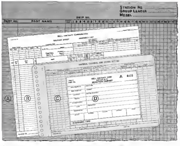


Instructions above are given to all assembly specification men which shows how to use the record chart.

By this process engineering drawings are eliminated from the plant and only templates are needed and used This does away with wasting workman's time trying to interpret drawings that unless he has been trained, he knows nothing about

With a loft being placed in this important position it is the main source of contact as far as trouble is concerned Any mistakes in design for any part no matter how small are immediately discovered here. Thus, when production is once started there are not a thousand and one bottlenecks sprinkled through the plant as various workmen find that the parts they are producing won't go together

To take care of this task the production engineering section was divided to include the process planning engineering and operation sheet writers, tool design, labor statistics or time study groups, the estimating department, and the schedules and progress reports group In general the production engineering section is responsible, not only for converting the engineering design into terms of factory production, but for the determination of all machine loading and machine demand, the man-hours required, etc., on the basis of which the various shop divisions are controlled so that their production agrees with the scheduled output.



"A" is the record chart kept of each assembly station "B" is the engineering release sheet One copy of which is turned over to the material control group one copy to the work order group and one to the production control group for each assembly unit "C" is the material control and storage record for all the material available in the plant. "D" is the rejection report consisting of four copies which are sent to the purchasing accounting and inspection departments and one for the vendor all of which are made out as soon as a part is rejected.

The function of the planning engineers is to study the drawings as released by the engineering department to assure themselves that the parts, if made according to the drawings, will definitely fit together to produce the desired dimensions and assure proper functioning. They see that the limits called for can be realized in a practical manner, and if not, suitable means for insuring that dimensions and limits are provided which can be held by ordinary manufacturing operations. The planning engineers are available for consultation by the engineering department designers on all questions on manufacturing practice to guide them in their detail design

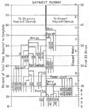
In general the responsibilities of the other departments working towards production are: (1) the tool design department whose responsibility is the specifications for purchase, design and the putting into operation of all tools. They work in close cooperation with the mold loft in order to take maximum advantage of lofting, (2) the work order section which is responsible for issuing orders, ordering required material and control of all receiving, shipping and stocking of this material; (3) the purchasing department responsible, as is usually the case, for all purchases of every kind, (4) the production control section whose duty is to interpret the master schedule in terms of actual unit parts and to assign the particular time at which any part is to be placed into production in order that it may be completed at the time it is required for assembly. It is their responsibility to see that the work order, the tools and materials are delivered at the proper time so that previously arranged schedules may be met

With the work thus allocated to these departments the factory division does not need to concern itself with any problems other than the administration ot labor. It is its responsibility to produce various parts within the standard time as determined by the time study personnel, using the tools and following instructions as specified on operation sheets

To make sure that the standard schedule, as it has been set up, is correct, the labor statistics or time study group make stop-watch time studies of the production elements of each operation in the usual manner, and also studies the elements of which the nonproductive time is composed. With these as a basis they establish standard time for any operation or assembly. Incidentally, the time study standard consists of the studied productive time plus 25 percent for relaxation, departmental allowance, depending on the particular nature of the work. With this once established it is not such a tremendous problem for the factory personnel to see that the work is done within this time.

Sequence Diagram

When the standard time has been obtained from the fabrication of the airplane a sequence diagram is made under the direction of the production control department. This is the schedule which controls the number and flow of materials through the preliminary fabrication processes to the final assembly line. Entered on the diagram are parts of the airplane indicating the points at which, during the progress of the construction of the Airacobra, each assembly is to be incorporated into the main structure. Each part is carried out to include details of each airplane group so as to provide a graphic chart of the time on which they must be placed into production in order to arrive at the assembly point at the proper time. In order to make this work efficiently, the diagram resolves all the details of the airplane into six priority groups. For instance, all parts in priority group one must be started before any of the parts in group two are started, and so on for the various groups. Each priority is further subdivided into groups having various degrees of preference within the groups. With this, any part following in priority group one would naturally take precedence over any part having a higher number

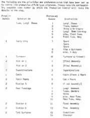


The sequence diagram is made out at the time an order is placed which indicates at what time parts of the airplane are to be started and what time they are to be completed. Each unit of the airplane is given a number as shown on the diagram.

Priority Production Control Boards

Now that all of the parts of the airplane have been given a standard time, as well as priority group number and preference group number, the names and numbers of the parts are entered on work orders in the form of 3x5-in cards which are racked up on a control board in each fabricating department in accordance with their priority. In order to produce parts in the sequence in which they are required it is only necessary to pick up the work orders in the sequence in which they are set up on the control board. The production control department is responsible for setting up these cards in sufficient time

Each department has its control board on which are listed the work order cards by their priority and preference number. As work is done they are moved along the board finishing at the upper left hand corner. Notice the red overtime tabs



Every part of the Airacobra has a priority and preference number determining its place in the production order. A few are illustrated above

to complete the part as required In the case of a change being made by the engineering department on any part, for any reason, the changed part immediately takes its proper place as to priority and sequence, and thus automatically is placed into the system in the proper order

Everything is planned in the factory around the system just described so that at no time will the process get out of hand and disrupt the whole production schedule In case the requirement for any part is of such urgency that overtime work is justified, a single red celluloid marker is clipped to the work order card. If the urgency justifies Sunday work two red markers are placed on the card With this system it is unnecessary to maintain voluminous files or records indicating the status of any part, as a glance at the control board in any department immediately indicates the status of the progress of the work

No cards are placed on the control board unless both the material and tools are available. In case tools or materials are not available the cards are retained in the control office, filed according to priority and this file is the basis for diligent follow-up to expedite the tools or material as the case may be

Out on the control boards, when work has been completed the card occupying the top position is removed and the one that was in second place is then put first, and each succeeding card is jumped up one file Walking through the plant and glancing at the top card in each control board gives any of the factory personnel a quick and concise picture of just how the material is flowing through the plant

Work Order Section

The control of the division of factory labor for various production processes, and the assigning of material to be used, is left in the hands of the work order section This group consists of the work order group, the material control group, raw stores, and shipping and receiving records group In order that they may keep complete control, no work is to be done in the factory without a work order except such routine work as factory maintenance and so forth This applies to every factory department The experimental department, however, is not considered part of the factory organization, but a branch of the engineering, and everything done for them is handled in the same manner as if this department was an outside vendor Placed in the hands of the work order group is the power to determine and specify the quantity of parts which are to be made at any one time. However, orders for tools are not handled by this group, but equivalent paper work was initiated for this to the tool design group

Before material is bought and stored in the plant it is necessary for the material control group to place orders for its purchase for the purchasing department (for which this group maintains records) This group maintains records as to proportionate evidence of the kinds of materials used by past contracts with a view to establishing a minimum stock of all kinds The issued requisition is based on advanced bills of material as supplied by the engineering department for such items that require a long delivery date, such as forgings and so forth From previous records they determine a proper percentage of overages for each class of material allowing for losses through spoilage rejection, etc

With the general function of each of the departments thus outlined, a description of the production and assembly lines can be better understood The 15 stations previously referred to run down through the center of the plant along two individual assembly lines To one side of these are grouped the press processing departments which take care of the heavy stampings, and so forth Next to this is the machine shop and tool room for supplying production lines with the necessary jigs and fixtures

The Assembly Line

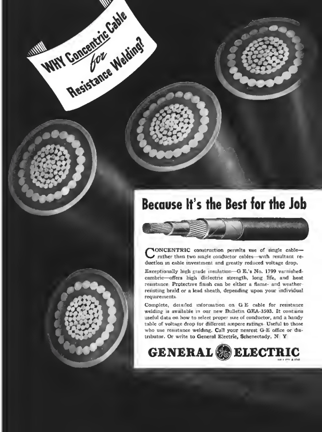
These two departments occupy one-half the plant on one side of the assembly line, while on the other half are located all the subassembly departments Each one of these departments has its own production line feeding into the correct station along the assembly line The first parts to be made are the basic parts of the fuselage The Airacobra has been designed so that the main structure of the fuselage consists of two longitudinal beams extending from the nose back to the point behind the engine, with the rear engine installation placed a little behind the center line of the wing, so that all main sections attached to the fuselage outside of the tail are attached to these two longitudinal beams forward of the engine. These two beams are assembled by means of our lofting practice and are later joined together with the center section and when completed are placed on a movable jig which will eventually start down the assembly line. These movable jigs then feed through their own department just to the rear of station one so that, as the basic fuselage structure is completed, it is ready to be rolled into the beginning of the line When it leaves this point the basic units of the fuselage have been assembled to a point just aft of the engine The first four stations then complete the assembly and installation of units inside the fuselage which prepare for lowering the engine into place at station five. From here on, all subassembly lines feed into the main assembly line from the right as it travels down the plant. At station six the pilot's cabin and doors are attached having been first sub-assembled in their section at the plant. Control surface and the rear section of the fuselage then feed into the line at station nine The next three stations allow for the installation of small parts

The wings follow down a subassembly line along the section of the plant, a little removed from the main assembly line Wing tips are made separate and are attached to the wings just previous to installation of the wings on the ship During the last three stations the wings and landing gear are attached so that when station 15 is reached armament, instruments and final detailed equipment can be installed

Building the First Plane

The engineering department sends all of its completed drawings directly to the loft where the fair lines and templates are drawn coordinating each individual unit The experimental department, which is under control of the engineering department, then makes all of the parts and assembles the first airplane making corrections on drawings, templates, and tools as may be required. After this they turn over to the production part of the organization the tools, templates, etc, and assemble a second airplane with the parts which this time are made in the production plant The assembly of this second ship is with the assistance of a member of each department in the main plant. This trains the plant personnel to assemble the airplanes and also gives them an opportunity to see the work being done by each of the other departments

When a change is needed in the design of the airplane, perhaps at the request of a customer, production is not stopped and the parts continue to go through the plant as before The changed parts are then produced separately and are changed on the ship by a separate crew thus eliminating a complete stoppage of the assembly line for some comparatively minor part. This crew, making the change, then works slowly back down the subassembly line installing the change in the ships which are being produced in such a fashion that it does not interfere with the production However, this working back is not started until all of the manufacturing fixtures are ready so that once the change is started it can be made in a minimum of time



Douglas Production

(*Continued from page 59*)

ordinated and merged into a supreme defense enterprise Consolidated will provide the engineering personnel and technical data and designs, Ford will build parts and sub-assemblies for the huge bombers, and the Douglas organization will provide experienced management, technical skill and production "knowhow"

Equipped with "blackout" and other defense provisions, the Tulsa plant will employ in excess of 12,000 men and women The plant's principal assembly unit will be an individual building, under whose roof production lines will provide straight-line flow for nearly four-fifths of a mile, making this the world's largest bomber assembly plant.

Under national defense pressure all-time records for speed and efficiency are being shattered in construction of the company's huge new "blackout" plant at Long Beach.

In erecting four of the assembly units structural steel was raised and riveted into place at an average rate of nearly 120 tons daily, a feat unprecedented in the history of such undertakings, according to steel construction authorities. With all the 12 buildings already in various stages of completion, airplane production is expected to begin in some units of the 200-acre factory considerably ahead of recent estimates.

Progress in the race against time—the universal defense bottle-neck—was made possible by extensive preparations long in advance for engineering and tooling, machinery and material purchases, and training and hiring of skilled workers. These preparations are enabling many departments to swing into action before the buildings are finished

As soon as walls and roofs provide shelter, machinery and equipment is being installed in buildings still under construction Carloads of tools, jigs, sub-assemblies, parts and materials are flowing in from suppliers the country over

Providing a total of some 1,400,000 square feet of production area, the plant incorporates defensive arrangements, construction techniques, and production systems never previously employed

Invisible at night from the air, all structures will be artificially lighted, fully air-conditioned, carry duplicated utility services, and protect vital supplies by underground storage Added safety for plant and employees in event of air attack is provided by decentralizing the larger units and housing them in 12 separate buildings spaced to afford the maximum protection Completely windowless, lacking even skylights, the buildings will always be bright as day inside, but no tell-tale gleam could escape at night to aid any possible aerial "spotters" Light traps are provided for at all entrances to complete the "blackout" and render the plant altogether invisible from the air, and almost so from but a few yards away on the ground To make the structures less visible by day, all are flat-topped, offer no light-reflective surfaces, and are colored to match the area's special paving and blend into the landscape

Paralleling the plant's unique construction will be its new and efficient production methods, the modern machinery and equipment, and the straight-line assembly techniques to be installed. The types of equipment and manner in which it will be laid out will place this among the aircraft industry's most efficient and highly-mechanized production units

Output will be greatly augmented by employing major parts and sub-assemblies built by large automotive and manufacturing plants in eastern and middle-western industrial centers Such plants as those of Murray Body, Briggs Manufacturing, Pullman-Standard Car Manufacturing, Fleet-Wings, and McDonnell Aircraft are now getting into production of airplane sub-assemblies under Douglas sub-contracts that are expected to eventually pass the $100,000,000 mark In making their resources and facilities available for airplane sub-assembly production, these plants joined 2000 other firms throughout the country who now supply humming Douglas production lines with raw materials, parts, tools and equipment.

Headquarters recently were established in Detroit, Mich, for Douglas engineers and material experts assigned to supervise the vast flow of equipment, parts, and sub-assemblies from eastern industrial centers to the company's plants in Southern California

With personnel needs vastly increased under national defense production impetus, the company's educational and training activities assume greater significance than ever before. Its educational efforts have been widely extended in a dozen directions, and a large-scale training program has been launched to provide skilled workers for the Long Beach plant In cooperation with various local educational institutions, special courses are being offered in aircraft assembly methods Thousands of men with experience in shipyards, oil fields, sheetmetal plants and machine shops have been enrolling for the courses, and it is estimated that by June approximately 1,000 will be graduated each month.

With more than 1200 already assigned to the Long Beach plant by May 1, additional workers will be added at a rate expected to approach 500 per week. During coming months thousands of men and women are to go on the payroll, for between 16,000 and 20,000 will eventually keep the plant's production lines rolling 24 hours a day

Supervisory and other key employes are to be provided by the company's Santa Monica and El Segundo plants. The supervisors and leadmen already selected are attending special lectures and conferences designed to acquaint them with the new high-speed production techniques of the Long Beach factory At Santa Monica, trainee machinists, planning, production control and other technical workers are taking special training courses.

At both the Santa Monica and El Segundo plants, designs and engineering data supplied by Long Beach personnel are being converted into mockups, templets, dies, and several prototype airplanes. These will be completely tested before their production begins at the Long Beach factory Upon completion of the plant, all design, engineering and production problems will have been solved long in advance.

As the nation watched construction begin on the new Long Beach and Tulsa factories, the main Douglas plant at Santa Monica was quietly but swiftly preparing for its own greater role in the new drama of defense. The object, to make time the hero instead of the villain of the drama of accelerated production, now universally recognized as the No 1 problem of industry and democracy

Having successfully attacked one enemy of efficiency,—waste of materials—Douglas engineers and production experts were out to conquer waste of time and motion. They inaugurated a new high-speed airplane assembly technique designed to slash the elapsed time between the fabrication of parts and completion of the airplane, and bring into sight the long-sought mass production goal That technique comprised a coordinated program of radically streamlined production lines, fuselage and wing assemblies on tracks, re-routed movement of materials new high-speed machinery, additional buildings

A new plant layout department was created especially to map plans for speeding up shop departments and assembly lines by reorganizing them on a "progressive" basis The goal, to send parts and materials through the factory in unbroken, continuous flow until they roll out the door in the form of finished airplanes Wherever the straight-line technique was launched, scheduling and planning were found to be greatly simplified, handling of mate-

rials was greatly reduced by the elimination of backtracking and crosshauling, and production per given area of floor space was nearly doubled. Parts from fabricating departments or outside production flow into the major departments and emerge as complete sections of wings and fuselages. The flow of materials is virtually continuous, moving from jig to jig at regular intervals, without going into storage piles in between. Complete assemblies for attack-bomber fuselages and wing sections themselves are simply put on tracks and moved along, conserving production space and accelerating operations.

So vast has Santa Monica plant become it has taken on the aspects and appearance of a progressive and well-organized city, for today the "Douglas community" of Santa Monica boasts its own fire and police departments, telephone system, radio station, bank, post office, restaurants, libraries, street railway, service garages, street signs, schools, hospitals, and recreational and athletic leagues. Many of these are more extensive in size and scope than are usually afforded by actual cities of equivalent population.

Most spectacular and significant of the company's mass production machinery are its four giant Guerin Process hydro-presses. To the 5000 and 2000 ton presses already in operation at the Santa Monica plant, there recently were added machines of 650 and 250 tons capacity, bringing available pressure capacity to a phenomenal total of 16,800,000 pounds, and giving Douglas the aviation industry's largest line of hydro-presses.

Developed and perfected by Henry Guerin, production executive of Douglas Aircraft Company, the Guerin Process employs metal male dies and a "universal" female die of rubber to cut aluminum alloy sheet and in the same operation form and shape it with swift machine precision into complex airplane parts. The process is now in use under license throughout the aircraft industry, and enables volume output demanded for national defense. At the Douglas company's Santa Monica plant, the Guerin process is chalking up new production records, with the four giant hydro-presses turning out aircraft parts at an unprecedented rate, and accelerating toward a capacity output of more than 44,000 units every 24 hours, including parts as large as many produced in automotive plants.

To bring to Long Beach plant the operating advantages of the Guerin process and provide even greater production speed, Douglas engineers in co-operation with hydraulics experts of the E. W. Bliss Co., Brooklyn, New York, evolved a unique six-sided press incorporating six loading tables for high-speed operation. The unheard of output possible with a six-sided Guerin process hydro-press is expected to make and break production records.

Two such presses have been completed for Douglas and are being tested at the plant of Bliss Co. Of 2500 ton pressure capacity, these hydro-presses each weigh approximately 375,000 pounds, stand 25 feet high, and occupy an area about 32 feet in diameter.

In Douglas Aircraft Company's drive for accelerated national defense output a vital role is played by artist-engineers who are accelerating airplane production and facilitating the training and absorption of thousands of new employes. Members of the company's production illustrations department are turning out unique cutaway three-dimensional drawings which portray in simple fashion the manufacturing details of Douglas airplanes, and greatly speed the planning and operation of assembly lines for their mass production. So comprehensive are these "perspective" diagrams they may be read and followed at a glance by the assembly workers, greatly reducing the time required in reading and fathoming the usual shop blueprint.

On the basis of the engineering department's original sketches and plans, drawings of an entire airplane and its major structural assemblies are first prepared for and in conjunction with the planning, tooling, lofting and materiel departments as basic functional designs in setting up production lines and providing the necessary equipment and materials. Detailed drawings then are made of the minor structural subassemblies, and the control, hydraulic and fuel installations, so that each worker in each position along the assembly line has before him an easily-understood diagram of what he is to do and how he is to do it, just as each step will appear to the eye.

Pioneer of the aircraft industry in thus simplifying the complex construction procedures to speed output, Douglas began using the cutaway three-dimensional drawing in United States Army bid specifications as early as 1939, before the defense emergency crystallized and today is employing it for production use on all military airplanes.

To accelerate national defense production by facilitating greater standardization, Douglas recently released to the airplane industry all rights to its specially developed and patented method of flush riveting with 100-degree rivets. At a meeting of the National Standards Aircraft Committee Douglas representatives formally gave the aircraft industry, in the interests of national defense, all legal authority to use and derive the production advantages of the Douglas Company's patent No. 2,233,820. This patent covers the method of flush riveting sheetmetal airplane parts with rivets having any usual angularity of head, preferably an angle approximating 100 degrees. By such a process considerable flush riveting can be done without the otherwise necessary "pre-dimpling" of parts.

Use of such flush riveting on exterior surfaces decreases wind resistance and results in airplanes which are swifter, and aerodynamically more efficient. By its release the Douglas Aircraft Company has made the method available to the entire industry without cost or liability.

Devoting every energy toward the paramount goal of making America secure in the air, the Douglas organization is driving ahead on every production front, with the achievements already chalked up bringing into view the countless new and spectacular wings to come.

Lockheed

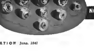
(*Continued from page 51*)

from the body jig, the airplane is moved to its final assembly station. The sequence of assembly from this point to final acceptance starts with the installation of the aft booms and empennage group, after which the outer wing panels, landing gear and power plant are installed.

The rear booms are assembled in a line parallel with the early final assembly operations. The wing and tail assembly line is parallel to the final assembly line, and is in itself a progressive line assembly similar to the above described progressive procedure for fuselage and center section. At the end of this line the entire empennage is assembled, including stabilizer, stabilizer tips, upper and lower fins, rudder and complete controls. The entire assembly is then transferred to the final assembly line for attachment at the end of the rear booms. The complete wings are transferred from the wing assembly line to the final assembly line for their attachment at about the same station.

Throughout this assembly and installation process, the Inspection Department maintains constant supervision and a complete check chart controlling the points at which equipment is installed.

When we have our 30 stations properly set up, they will be portable, and, we expect, tied together with cable and pulled by a winch on the end. This will be a modified conveyor principle, the entire line moving as a unit. Under this



plan, when an assembly comes out of the body jig, the one at the door must be finished and ready to move out to the paint shop for final touch up. This means that installations must be completed in an alloted time.

From the very beginning, U. S. Army representatives had great interest in the airplane and, through their close cooperation during the process of development and clearing up of the normal problems encountered, helped in bringing the airplane from development to production stage. Because of the outstanding performance and installation resulting therefrom, which had not heretofore been encountered by any other airplane of this type or by the Air Corps, it has been necessary for the Inspection branch to maintain very close coordination with the Air Corps headquarters and our engineering department. We have had a visit on the average of once every two weeks since last October from some representative of either the Air Corps Engineering, Air Corps Inspection or Air Corps Materiel Division, all this in addition to the constant cooperation and helpful advice of our own resident Army Inspection group.

The Materiel Division Inspection Staff of the Army has moved its office to Lockheed Air Terminal and actually conducted its inspection on the field. Prior to this, it has been necessary to fly the prototype of any ship to Dayton, slowing the coordination between Wright Field and our Engineering Department as much as a matter of months. In the case of the P-38 all this was completed before delivery, and only the accelerated service tests were made at Dayton. The tests were further speeded up by using three airplanes instead of one, as is the usual procedure. All static load tests were conducted at Dayton by the Air Corps with the services of our Engineering and Assembly group. This fine example of Army cooperation speeded the final acceptance of the airplane by many weeks.

We hope soon to go full speed ahead at a very high rate of production. The production ratio we hope to reach very soon will be due not only to the technical development of the airplane and the production program, but to another factor of equal importance. That factor is development of the personnel necessary to perform efficiently in the fabrication and assembly line, and the spirit and enthusiasm of the men for the performance of their individual tasks in this defense emergency. This goes far beyond the training of flush riveters mentioned above. The Lockheed Company for several years has sponsored extensive courses in connection with the local high schools. The highest cooperation has been received from school authorities, resulting in an organization well qualified to develop our employees along the lines especially adaptable to our requirements.

The company has been highly pleased with the enthusiasm of its employees in accepting this opportunity for trade extension education, there being more than 8,000 Lockheed and Vega workers enrolled in the spring semester classes in the schools of Burbank and nearby communities.

This education program has enabled thousands of employees to accelerate their proficiency in various occupations, resulting in up-grading and improved earnings for employees and increased production for this company.

However, every new model is a strange subject in all assembly details. Proficiency is a matter of repetition and takes time under the guidance of detailed supervision. At the beginning of every assembly line, development is by one unit which is usually crowded with men. The units are gradually increased to two, three, six and twelve until the floor space is completely occupied by the required number of stations. As this expansion develops, the original crews are divided and new teams are developed and that work is then spread out in a manner permitting increasing numbers to be employed in less congested fashion, resulting in vastly improved efficiency.

A few cycles of repetition should then be sufficient to obtain a rapid flow in the assembly line. Organizations are not over-night developments. As the development progresses, the aptitudes of personnel are observed and shifts of personnel from one phase of the work to another are effected to improve efficiency. It is highly essential that proper scheduling of material and parts, and purchased equipment, be accomplished in order to obtain uniform flow for maximum results.

Right now we have a motto in our plant. It is, "First Things First—and the First Thing is the P-38!"

Window Shopping

Bound Brook Bearings—An important catalog on bearings which provide lubrication when and as needed. Compo oil-retaining porous bronze, Bound Brook graphite inlaid cast bronze and Nigrum oil-impregnated hardwood bearings, their structures and applications described and illustrated. Bound Brook Oil-less Bearing Co., Bound Brook, N. J.

G. E. Fiberduct—Bulletin on General Electric underfloor raceway system; technical data, specifications and prices. General Electric, Bridgeport, Conn.

Eastern Midget Pumps—New and unique series of Midget pumps, "built to specifications" described in illustrated pamphlet. Eastern Engineering Co., New Haven, Conn.

Storage Battery Power—Latest issue for users of industrial storage batteries. Thomas A. Edison, Inc., W. Orange, N. J.

Naval Aviation

(Continued from page 41)

Service officers or from post offices.

An extensive training program for these civilian workers is now being carried on. It is realized that men with long experience cannot be hired and the simplest solution is to give them intensive training after they are employed. This work is a splendid opportunity for young men to learn a skilled trade.

The greatest single peace-time role of the Navy is to train its men for a time when they may be needed by the nation. The Navy Department has organized an efficient and smoothly operating training system for all its officers and enlisted men. Each month sees a larger number of men completing these courses and going out to join their operating units in all parts of the country.

Lear Radio

(Continued from page 90)

1. Loop sensitivity and noise ratio
2. Compass sensitivity
3. Compass accuracy
4. Compass uniformity
5. Time required to obtain a bearing
6. Degree of perceptible hunting
7. Tuning meter action
8. Degree of tuning error.

There are various other procedure tests which the compass tester records on the data sheet, such as the operation of all the various controls and interconnecting circuits.

The compass tester then checks the data recorded by the receiver tester to verify the results obtained, and to give us an added degree of assurance that our equipment complies with the specifications.

After this work is finished, the compass tester places the equipment on a shake table without the customary shockmount. The equipment is then subjected to vibration with accelerations of 7 G's, for a period of 20 min.

After this test, the equipment is brought back into the compass test room and its operation rechecked to see that there are no perceptible changes in its operation. If any changes are noticed, the reason must be determined and the causes remedied. In such an event, it is necessary to retest the entire equipment in the manner described.

Before being presented to the final mechanical inspector, each unit is spot checked by a final electrical inspector. The final mechanical inspector then goes over the equipment, making sure that everything is shipshape and commercially presentable.

In some instances, it is necessary to make composite tests by interconnecting several units which compose a system. Whenever this is necessary, the data sheets provided to determine whether or not the various pieces of equipment comply with the electrical characteristics are filled in and turned over to the chief inspector for his acceptance.

In order to see that specified performance characteristics are maintained, the engineering department has a division known as quality control. The function of this division is to determine whether the equipment accepted by the test department is in factual accordance with the engineering requirements. A complete set of data is recorded by the engineer who conducts these quality control tests. The division tests and inspects a predetermined percentage of all equipment accepted by the test and inspection department. This division also conducts accelerated life tests on various component parts of the equipment being manufactured, to determine whether any trends of weakness are developing, or have reached a perceptible stage. This division constitutes an important factor in maintaining the high standard of Lear Avia equipment.

Thus, from raw material to finished product runs a smooth chain of manufacturing activities. Four of our innovations in aircraft radio mass production have been found exceedingly valuable:

1. The maintenance of two departments to feed component parts to the assembly benches, cutting time required for initial manufacturing stages.
2. The use of sequence photographs by direct assembly workers to show them at a glance exactly how the worker's unit will appear when his operations are completed, and in what order the various steps should be done.
3. The pre-fabrication of chassis assembly cables, making possible the employment of semi-skilled labor on an operation which heretofore required highly trained personnel.
4. The establishment of a quality control division, under the engineering department to fully coordinate design work with manufacturing activity.

The limitations of space prevent a complete discussion of the simplification which has been introduced into our work without sacrifice of quality. We do feel, however, that the aircraft radio industry can entirely avoid the dread name of "bottleneck" no matter what demands are made upon it.

Lear Avia today is in an excellent position to accept the challenge of national defense needs.

NACA

(Continued from page 69)

was then asked to establish priorities on the suggestions received from its own members. This has resulted in the establishment of master lists from which the next year's university contracts will be selected. The coordinator's office is now at work to obtain proposals from educational institutions that are known to be equipped and staffed to handle these problems. All proposals that come in as a result of these negotiations will be submitted to the appropriate subcommittees and ultimately to the executive committee for final approval in the usual manner.

The work with university laboratories is only one of the fields in which NACA is cooperating with agencies outside of its own walls. Laboratory and coordination personnel make frequent visits to other governmental laboratories, such as the Army's station at Wright Field, the Naval Aircraft Factory at Philadelphia, the National Bureau of Standards in Washington, and the Forest Products laboratories in Madison. Contact is also maintained with research groups in foreign countries. Members of British research commissions have visited Langley Field recently, and the coordinator has exchanged visits with the research people of the National Research Council in Canada.

Fortunately, the value of aeronautical research in the National Defense Program has long since been recognized, and Congress has given tangible evidence of that recognition in the form of increased appropriations for new research laboratories and for the support of essential research in universities. Langley Field is now being expanded to the limit of the available property, and work is far along at Ames Laboratory at Moffett Field in California. At Ames, over $10,000,000 is being spent for a group of large-scale wind tunnels and for a fully equipped flight research laboratory. As has been recently reported at some length in AVIATION, a third laboratory has been authorized for engine research. The Cleveland airport has been selected as the site and work is now started on building and equipment.

The American people can rest assured that our armed forces in the air are not to be hamstrung by restrictions on essential fundamental research in aeronautics.

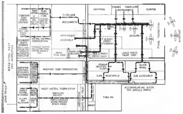
Vultee

(Continued from page 65)

duction of a substantial number of planes incorporating bothersome bugs" It is necessary to tighten up the "streamlined" engineering technique. This is done by a thousand and one methods all along the line, but the best way of putting it is to say that the plane to be placed in production gets more and better engineering than if it were a prototype development. Calculations are more exacting, wind tunnel test programs more extensive and physical testing more elaborate.

Of equal importance with the process of 'streamlining" engineering so as to minimize delays occurring between planning and production, there is the need to engineer the plane for production This is done by using standardized parts, simpler assemblies, methods of fabrication that lend themselves to high speed machine work, etc. A very important factor is that of designing the plane so that it can be produced in the maximum number of different component parts, all so designed and manufactured that they may be assembled with minimum effort This makes it possible to spread the work among more men and at the same time to see to it that every man has ample space to work in and equipment to work with The Vultee basic trainer is designed so as to take full advantage of forgings, castings and parts which may be finished very rapidly on automatic or semi-automatic machinery Extruded sections are also widely used. Design of the fuselage permits assembly of the engine and mount as one unit, the center fuselage with controls, accessories, instruments, etc, as another, and the tail group as a third. Much the same idea is carried throughout the design of the plane speeding final assembly

Finally we came to the production process itself in our race to beat the schedule on our first major contract Vultee is a relatively young company It has grown very rapidly and this has been a great incentive to all of the fore men and production people Most of these men have developed many fine production ideas in the course of their aircraft work but low production volume kept them from placing these ideas in practice Placing an order for 300 Vultee trainers gave many of us a chance to put our pet ideas to the test Throughout all production departments this process of attempting new production methods has been encouraged Not all of our ideas have worked, but the percentage has been high and there have been some notable achievements.



A schematic production chart of the Vultee plant Raw materials and parts are received at the left and finished planes are delivered at the right. Heavy lines represent the general flow of raw and semi-finished materials and parts through a series of production stages to the final assembly line

In the field of welding Vultee has pioneered the application of electric arc welding to quantity production of steel tube fuselage structures Perfection of the technique as applied to aircraft production has improved speed by about 25 percent over the best previous gas welding practice

We have also developed many special machines for the shop, and a very large number of special fixtures and tools for standard machines Among the special machines are to be found the three-leg Birdsboro press with rotary platen, permitting continuous pressing operation at a high rate of speed Vultee shop men have also perfected a revolutionary high speed milling machine which slices through light alloy castings like a hot knife through butter, cutting machine time to a small fraction of that previously required in many instances

We have also made use of the mechanical conveyor systems which are now being adopted by all major aircraft plants And many other mechanical developments have been perfected by Vultee men to speed the production line But, as commented earlier, it is always the men who get the job done. So if there is praise for Vultee in connection with our production record it must go to literally thousands of men who know their jobs and are doing them day in and day out As time goes on we will continue to build planes at an ever faster rate In a period of twelve months, while producing planes ahead of schedule, Vultee was also expanding its factory facilities a total of more than 450 percent Whatever production the emergency requires, we hope to meet it.

A Birdsboro three-leg hydraulic press, with a three-station rotary platen that permits continuous pressing operations by progressive stages of loading pressing and unloading, adds considerably to Vultee's production speed.

Cannon ON WINGS!

AIRACOBRA!

The only single engine interceptor pursuit airplane in production in the United States that carries an explosive shell firing cannon. They are now rolling off our assembly line to join the fighting forces of Great Britain and the United States Army Air Corps. In quantity production, the Airacobra is convincing proof of Bell's leadership in design, engineering and construction.

BELL AIRCRAFT CORPORATION, BUFFALO, NEW YORK

SCHATZ
Precision
AIRCRAFT
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POUGHKEEPSIE, N. Y.
Detroit Office: 2640 Book Tower ● Chicago Office: 902 S. Wabash Ave.
Cleveland Office: 403 Swetland Building ● Los Angeles Office: 5410 Wilshire Blvd.

Wing Mounting Guns

(Continued from page 87)

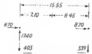
1, we notice that the fittings on the guns are so arranged as to tie in with the front and rear web. This is highly desirable as the local stresses introduced by the guns will be transmitted directly through the fittings to the main wing structure

Treat gun as a simply supported beam.

$$R_1 = \frac{15.55 - 7.10}{15.55} \times 742 = 403 \text{ lb.}$$

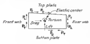
$$R_2 = \frac{7.10}{15.55} \times 742 = 339 \text{ lb.}$$

Now consider total *gun* loads acting on fittings which are located at R_1 and R_2.



It can be easily visualized that there are loads due to lift and drag which would have to be taken into account. It is not within the scope of this article to show how these loads are determined as the procedure is too lengthy But it suffices to say that after distributing the drag, lift and torsional shears to the members comprising the box beam and then adding or subcontracting gun loads above (dependent on vector sign) we then have total loads in each member

By employing the principles of unsymmetrical bending we are able to calculate the primary bending stresses on each of the chord members of the wing at the gun stations The sketch below indicates the vectorial distribution of drag and lift at a particular station



The lift is distributed into front and rear webs, P_L the drag is distributed into top and bottom plates, P_D the torsion is distributed to all four members as a running shear P_T. Thus by determining the primary stresses in chord members which are at each corner of above diagram and which run across wing in spanwise direction, we are then able to decide whether or not they are strong enough simply by comparing them with the allowable stresses in compression and tension for aircraft materials

Ford Engine

(Continued from page 93)

the new Ford aircraft engine, the two cylinder blocks and the crankcase are an integral aluminum alloy casting with the coolant jackets extending the full length of the cylinder barrels The cylinder liners are of the dry type and are made of centrifugally-cast oil hardened steel This form of construction gives the engine a strong rigid backbone and is intended to eliminate many of the difficulties encountered in high-speed aircraft engines of the in-line type The walls of the cylinder liners themselves are free from flanges and bosses to avoid distortion detrimental to the piston rings and their lubrication

The crankshaft is of the 6-throw counterbalanced type and is made of centrifugally-cast steel The design is such that the two connecting rods from opposite pairs of cylinders both seat on the same crankthrow using the same floating big-end bearing This arrangement permits connecting rods of equal weight and balance to be used and facilitates production and the availability of spare parts The pistons are nearly square, that is to say their length is approximately equal to their diameter so as to improve heat dissipation. Each cylinder has two inlet valves and two exhaust valves actuated by two overhead camshafts with the cams seating direct on the valve stems

At first glance, the supercharger appears to be somewhat bulky but closer examination reveals that it blends neatly into the streamlined nose of a fighting plane The air compressor is driven by an exhaust-gas turbine and the unit is designed as part of the engine This idea also is carried out with regard to the air intercooler and the latter fits snugly between the two banks of cylinders The supercharger is of Ford design and manufacture and embodies the results of extensive research with air compressors and exhaust-gas turbines

Direct fuel injection is used instead of a carburetor and the engine is designed to run on 100-octane gasoline. As only air is delivered from the supercharger the normal overlap of the exhaust valves and the inlet valves can be increased so as to improve the scavenging and at the same time cool the exhaust valves and the head of the piston. This takes place near the top of the piston stroke before fuel injection commences and the only loss is a small quantity of air

Aerodynamically, the new Ford aircraft engine is very clean. Only the air intake and the exhaust outlet of the supercharger project into the slip stream after the cowling has been placed around the engine

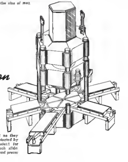
With an engine of this type, it is claimed that an increase in power output of 100 percent or more can be obtained over a normally aspirated engine by means of supercharging and other improvements The increase in power output due to the use of an exhaust-driven supercharger instead of one of the gear-driven type is said to be approximately 15 percent According to the latest reports from Detroit, the first 12-cylinder Ford aircraft engine should be ready for its tests this summer It is expected to develop 1,800 hp for take-off at 3,000 r p m. and 1,500 hp at an altitude of 30,000 ft Its weight is estimated at approximately 1,600 lb, or slightly less than 1 lb per hp

Aircraft Tubing Book

A new book in loose leaf form has been brought out by the Summerill Tubing Company of Bridgeport, Pa, giving all the essential information on aircraft tubing Included are sections dealing with methods of manufacturing seamless steel aircraft tubing, specifications for various alloys, valuable information on welding and design data for use in aircraft construction

This book should be of extreme value to the aircraft industry as it contains practically all available data on tubing In addition to the excellent information obtained from the Summerill Tubing Co, data was also supplied from practically all the leading aircraft companies

Although it has been the aim of the company to make generous distribution of copies to all technical men in the industry, it has been necessary to place a limit on complimentary copies because of the tremendous number who find it useful As a result they have decided to sell the copies for $1.50 each with wire binder and fiber cover, and $2.00 each for a ring binder and Deluxe cover An order to the Summerill Tubing Co, will get you one.



Sperry Sub-Contracting

(Continued from page 77)

amounting to about 2,000 hours of labor This was strictly an educational order, as there was no need for the extra facilities at that time

Other sub-contractors were gradually added in the months that followed By April of 1939 work amounting to 25 000 hours per month was flowing to the parent plant from 21 sources of supply By October of 1939 expansion had really begun, and 23 firms were supplying Sperry with 60,000 hours of work per month By July, 1940, 35 sub-contractors were providing 170,000 hours of work per month. At the present time some 50 firms are turning out 250,000 machine hours per month By the middle of 1942 a conservative estimate is that these figures will be doubled. When the market has already been microscopically combed to secure the present output, Sperry taces very real problems in attempting to double its farming-out facilities

How the job was done

The first step in a sub-contracting program is to decide how much work must be farmed out Sperry does this by projecting a sales forecast upon a statement of unfinished business Work to be done is broken down into types milling, drilling, lathe, and so on Present plant capacity is then set against these figures, and the overflow must be let to outside firms In short, Sperry plans are based on accurate machine loading charts At present Sperry plans to sub-contract one third of its machine-labor output.

The next step is to find the sub-contractors With few exceptions, Sperry has found the firms with which it is now working, but it has received valuable help from the Air Corps, the Ordnance Department and the Navy When a possible sub-contractor has been found, his name is immediately cleared through government channels to make sure he is not about to receive a prime contract Planning engineers from the parent firm have studied the sub-contractor's equipment, his product, the type of labor he employs as well as figured his potential production

If the sub is approved he is given an educational order, which often consists of a job requiring several operations A machine shop, for example, may have a variety of equipment but may use some of it so poorly that only certain of its machine operations would be satisfactory Thus the educational order educates both the sub-contractor and the parent company Five or six firms that have been tried out did so poorly on educational orders that they either voluntarily withdrew or were rejected from further orders

Early in its farming out history, Sperry decided that sub-contracting was something other than mere purchasing Any purchasing department these days has a difficult enough job, but it is one thing to go out and buy a complete unit that some one else has made, and quite another job to teach someone else to take over a tough manufacturing operation that you have been doing yourself Consequently sub-contracting is a special unit of the planning department It is looked on as a branch of manufacturing At Sperry, sub-contracting is headed up by C W Petersen, who reports to L B Coon, Planning Manager It is significant that one of the most active men in sub-contracting is E U Da Parma, who is Mr Coon's assistant, but as such is not actually in the sub-contracting department Engineers from the methods department play an important role, as will be noted later The responsibility for sub-contracting, as well as the responsibility for the entire output at the Sperry plant, rests in the capable hands of Louis F Malkovsky, Vice-president and Factory Manager

It might be said that every day is "M" day with the sub-contracting department, as help given to the affiliated firms consists of men, methods, machines and materials In every case the sub contractor has been treated as though he were an extension of the Sperry plant. His problems immediately become Sperry's problems Both methods engineers and shop foremen, who have spent years in learning how to manufacture a specific product, have given the sub-contractor the benefit of their "know how," which is the most valuable asset in production work today

Help given to the sub-contractor begins with the first report, which is made prior to any educational orders This survey is an engineering study of the plant, its production control, scheduling system, machine tool equipment, machine load, inspection routine and financial set-up If there is a flaw anywhere along the line, corrective measures are recommended and must be followed through The survey includes floor space, all types of equipment and possibilities for expansion.

In addition to the Sperry blueprints of parts to be made, explanatory process sheets and detailed instructions on the making of each part are provided. If special tools are needed these are provided, or prints are furnished so that the firm can make the tools in its own shop Occasionally new machines or tools need to be purchased and in such instances help is given in securing them. In some instances sub-contractors have received machine tools or equipment which Sperry had ordered for the parent plant If the firm has a foundry it may be loaned patterns

One of the chief helps that is given to sub-contractors is that they are taught to put their shops on an efficient operating basis To many small firms the term "machine loading" has meant nothing In the past they have secured orders for work and got it out as soon as possible—but there was no real planning or scheduling of work When unexpected difficulties developed, production was held up all along the line Sperry methods engineers, treating the sub-contractor as one of its own manufacturing divisions, have developed efficient methods out of such confusion Each month, or more often during the early educational process, progress reports are prepared, giving a record of actual performances on each part of the order plus future requirements Sperry follow-up men circulate through sub contractors' plants, watching shop schedules and machine loads for possible bottlenecks and choke points. They aid in securing materials and tools

In one plant a duplicate of the entire Sperry Addressograph system was installed for routing, dispatching and scheduling of orders In several plants personnel problems and the manipulation of man power toward increased production are regularly discussed with the management Another plant was aided in securing annodizing equipment

The problem of price is always an important one, and Sperry has adopted the wise policy of doing everything possible to help sub-contractors make a reasonable profit on orders. The parent company recognizes that a firm often cannot quote accurately on new parts or what may be an entirely new method Therefore Sperry passes on to sub contractors its operation sheets and its time sheets, showing what it has cost to build the part in question Thus a fair rate per hour can be set Early educational orders are usually on a cost-plus basis

In order to eliminate the customary delay in obtaining and checking quotations a flexible system has been worked out with some of the well established sub contractors This consists of fixing a money rate per hour for each plant by carefully considering the wage scale burden rate and reasonable profit This rate is then applied to the pre-determined Sperry time estimates If materials are not furnished by the prime contractor, the sub-contractor is allowed an additional handling charge

If the sub-contractor plans a plant

expansion on the basis of Sperry orders, he is given help in finding new factory facilities and in securing new equipment

Not only do methods engineers and follow up men visit the plants regularly, but department heads, engineering specialists and shop foremen are regularly called upto to help solve special problems

Inspection system

At first all inspection was done at the home plant Parts were made in the sub-contractors' shops and shipped to Brooklyn This did not prove to be satisfactory Mountains of rejected parts piled up which had to be returned Some of them needed only slight additional work to be satisfactory and this involved extra expense for cartage Some parts were rejected once, sent back for additional work, and then were rejected later

Sperry inspectors now do their work in the sub-contractor's shop In the busier shops as many as four inspectors work full time In other shops Sperry inspectors call at regular intervals to look over the work These men are not part of the sub contracting department, but report directly to the head of the inspection department

A list of Sperry sub-contractors is almost a cross-section of American industry They range in size from the Eastman Kodak Company with its thousands of employees down to the New Jersey Gear Company with just 54 men on its payroll. Commercial products in the regular lines of these firms also cover a wide range cream separaters, printing presses, fishing reels, cans and canning machinery, hand pumps, sewing machine motors, cameras, foundry work, metal novelties, postage meters, gasoline pumps, cigar making machinery, cigarette vending machines, oil burners and electric razors.

The bulk of the parts sub-contracted is machine shop work Some 20 operations are carried out, the amount being in this order drill press, engine and turret lathe, hand screw machines, profiling, milling, bench lathe, Gorton milling, hobbing, grinding, automatic screw machine The balance occupies only a small percentage of the total time used

Toughest problems kept at home

Although Sperry is now farming out work that it formerly believed no one else could do, the most difficult manufacturing processes are still kept at home. The delicate work of lapping the pivots on the ends of the gyro shafts and the balancing of rotors are representative of work that cannot be done elsewhere

A few sub-contractors are doing assembly work One firm does some electrical assembly, and another assembles an entire unit, but the bulk of Sperry assembly is done in its own factories One reason for this is that several assemblies must be given extensive tests when the assembly process is about three-quarters finished

The Future

Other prime contractors searching for smaller firms with whom to share the work should not enviously assume that all of Sperry's problems lie behind. The past has been difficult enough, but the future presents even tougher problems The company plans to double its sub-contracting facilities It has already searched diligently to find the 50 firms that make up its present list, and to find 50 more will require tremendous energy and much time

As in the past, Sperry will continue to work closely with all government agencies in the securing of new firms Its sub-contracting head C W Petersen, is spending considerable time working with the Chambers of Commerce of various cities, as well as the Division of State Planning Several good leads have developed from such methods

Another source of sub-contracting that looks promising is from groups of three or more small shops that work together as a unit The OPM in its excellent "Farming Out Bulletin No 5" reports that approximately half of the machine tools in the country are located in small shops. Many of these shops do not have sufficient equipment to do a complete job, but when tied in with other small shops can form part of a group that can do real production work

Sperry has several such groups that perform as one sub-contractor Such groups need a coordinator who becomes the liaison man between the group and the prime contractor

Sperry is also looking forward to securing some relatively large firms who now have machine shops engaged in regular commercial work Many of these firms are going to find themselves unable to get metals for their regular products It will be a case of getting in on national defense orders or closing down the shop Some firms of this type are already looking for sub-contracts They offer a great possibility for many prime contractors.

"There is no easy solution to sub-contracting," said a Sperry official recently "It's hard work You can't just drop the prints on somebody's lap and expect the parts to flow back to you You have to get in there and sweat with him It's the only way to do the job"

Aircraft Expansion

(Continued from page 43)

craft engine makers, Pratt & Whitney and Wright, will probably be asked to revise their rapidly expanding production schedules to turn out more engines in the higher-power groups. Hamilton Standard and Curtiss Propeller are expanding extensively and will continue to be the chief source of propeller supply. The Aeroproducts Division of General Motors will furnish some of its own propellers and sub-contractors will be impressed into service by the parent manufacturers.

The new bomber program will be an extension of the Knudsen plan, the first phase of which is now being worked out. Briefly, the original plan called for 100 per month each of the four-engined Consolidated B-24D, and the twin engined North American B-25 and Martin B-26. These ships will be put together from automotive industry manufactured sub-assemblies in four government owned assembly plants operated under management contracts with aircraft manufacturers. Two of these plants will be devoted to B-24D production, one to be operated by Consolidated at Fort Worth, and the other by Douglas at Tulsa. Sub-assemblies will be manufactured by Ford in a new 720,000 sq ft plant near Ypsilanti, Mich. This plant may be further expanded to provide an assembly line one and one-quarter miles long and the final assembly will be done there as well as at the other plants.

A third assembly plant will be operated for the War Department by North American at Kansas City where B-25s will be constructed from sub-assemblies provided by General Motors. No announcement has been made as to the location of the sub-assembly space but there are rumors of a possible plant location in the Tennessee Valley.

The fourth of the War Department plants is under construction at Omaha to be operated by Martin for B-26 assembly. Chrysler has set aside 600,000 sq ft for manufacture of the fuselage forward and mid-sections. Hudson will be responsible for the after portion of the fuselage. Goodyear will employ 8000 men and use 1,000,000 sq ft. of space for wings and tail surfaces.

While this plan is in operation, the three models selected will also be in quantity production under the regular program in the parent plants of Consolidated, North American, and Martin. This means that the automotive subcontractors will be faced with the necessity of finding many new secondary sources of minor assemblies and parts

AVIATION INDUSTRY EXPANSIONS FROM JANUARY 1940

Aircraft

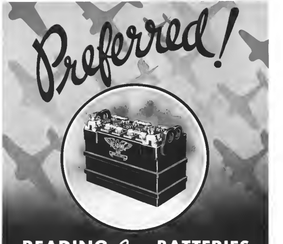
254,467 Sq Ft Built on Dec. 31, 1940, 15,965,931 Sq Ft Under Construction)

Company	Location	Space (sq ft)	Men employed	Cost	Model	Rate of Production
Adel Precision Prod Aereo Corp		35,000	440			
Aeronca	Middletown, Ohio	45,000	340	$75 000		
Air Associates	Bendix, N. J.	100 000	750			
Air Parts	Bridgeport, Conn		200			
Aircraft Accessories		46,000	400			
Beech	Wichita, Kansas	425 000	4,000	2,384 000		
Bell	Niagara Falls, N. Y.	494 000	5,500	1 500 000	P-39	
Bendix Aviation		2,950,000	21 000			
Boeing	Seattle Wash	1 832 000 190 000		7,300,000		
Brewster	Long I. C. N Y	884 000	7,900			
Cessna		260 000	1,600			
Columbia Aircraft		55 000	200			
Consolidated	San Diego, Cal	1,910 000			B 24	
Consolidated	Fort Worth, Tex			10,000 000		
Culver	Wichita, Kan	295 465	130			
Curtiss-Wright Corp	Buffalo, N. Y	1 200 000	12 000	12 000 000	P-40	10 per day
Curtiss-Wright Corp	Columbus, Ohio	1 200 000	12 000			
Curtiss-Wright Corp	St Louis Mo	1,200,000	10,000	11 000 000		
Douglas	Long Beach, Cal	1,422,350		11 000 000		
Douglas	Tulsa, Okla			10 000 000		
Ede Aircraft	College Pt. L. I	47,000		365,000		
Engineering & Research		74,000	400			
Fairchild		129,000	1,223			
Fleetwings, Inc	Dallas, Texas	180,000	1,185	1 000 000		
Ford	Ypsilanti, Mich	720 000		11 000 000		100 per mo
Glenn L. Martin	Middle River, Md	1,604,320	25,000	24,000,000	B-26	
Glenn L. Martin	Omaha, Neb	1,288,326				
Goodyear Aircraft Corp		1,000				
Grumman	Bethpage, L. I	500,000	4,000	2,000,000		
Hardman Aircraft Prod		70,000	365			
Harvill Aircraft Die Co		65,000	362			
Howard Aircraft	Chicago, Ill	68,000				
Intercontinent	Miami, Florida	100 000		750 000		
Jack Heintz, Inc		90 000	350			
Kellett	Philadelphia Pa	60,000			KD1-A	
Link Aviation Devices	Binghamton, N Y	176 000		323 432		
Lockheed	Burbank, Calif	1,067,000	10,000	4,000 000		
Lockheed, Vega Div	Burbank, Calif	1,090,410	21,650	3 500,000		
Luscombe	West Trenton, N J	30 000			8-A	
McDonnell Aircraft		38,000	140			
Monocoupe	Orlando, Fla	22,500				
Morrow Aircraft	San Bernardino Cal	28 000				
N American	Dallas, Texas	1 000 000	12 000	7,000,000		
N American	Inglewood, Cal	1,000 000				
Northrop	Hawthorne Cal	500 000		1,000,000		
Piper	Lockhaven, Pa	73 000	1-100			
Porterfield	Kansas City, Mo	22,000				
Republic	Farmingdale L. I	1,000 000		9,000,000		
Rohr Aircraft		175 000	600			
Ryan	San Diego, Cal	160 000	900	200 000	ST 3	
Solar Aircraft		114 000	829			
Southern Aircraft	Garland, Texas	114 000				
Sperry Gyroscope		300 000	1 900			
Spier Aircraft	Jersey City, N J	17 000				
Stearman Div Boeing	Wichita, Kansas	600,000	4 000	3 500,000		
Taylorcraft	Alliance, Ohio	49,400	363	200,000		
Timm		55 000	260			
Vought-Sikorsky	Stratford, Conn	258,000	3,900	1,600,000		
Vultee	Downey, Cal	760,000				
Vultee	Nashville, Tenn	428 000		4,000,000		
Waco		98,960	310			
Warner Aircraft		33,000	165			

Engine

(3,061,749 Sq Ft Built on Dec 31 1940 4 428 479 Sq Ft Under Construction)

Company	Location	Space (sq ft)	Men employed	Cost	Model	Rate of Production
Allison		1,500,000	11 000			
Allison	Anderson, Ind	211 700 (Foundry)				
Bohn Al & Bros	Detroit Mich			$1,216,000		
Buick	Grand Blanc, Mich			24,313,150		
Buick	Melrose Pk., Chicago	1,000 000	10,000	31,000,000	P&W	300 per mo. (exptd.)
Continental Motors		440 000	3,800			
Ex-Cell-O	Detroit, Mich			1,669,678 (Engine Parts)		
Fairchild	Hagerstown, Md	Tripled		1,478,800		
Ford	Dearborn, Mich			21,965,420		
Gen Electric	Everett, Mass			5,873,800 (Supercharger Plant)		



Company	Location	Space (sq. ft.)	Men employed	Cost	Model	Rate of Production
Jacobs	Pottstown, Pa			1,000 000		
Kinner Motors		40,000	160			
Lycoming Div		317 000	2,000			
M B Mfg Co	New Haven, Conn			96,000 (Parts)		
Menasco	Burbank, Cal	63,500				
Menasco	Burbank, Cal			200,000 (For new mchy)		
Otis Elevator	Harrison, N J			6 954 735		
Packard	Detroit, Mich	460 000	14,000	38,000 000		
Pratt & Whitney	E Hartford, Conn	1,474 000 434 000		14,799,000		
Ranger		108,000				
Studebaker	So Bend Ind			36,799,300		
Thompson Aero Prod	Euclid, Ohio			11,198,000 (Parts)		
Worthington Pump	Holyoke Mass			369,000 (Parts)		
Wright Aero Corp	Cincinnati, Ohio	1,694,000	12–15,000	37 000 000		
Wright Aero Corp	Paterson, N J	540 000 50,000				
Wright Aero Corp	Fairlawn, N J	450 000 110 000				
Wright Aero Corp	E Paterson N J	433 000				
Propeller						
(452,560 Sq Ft Built on Dec 31, 1941; 108,000 Sq Ft. Under Construction)						
Aeroproducts Div., Gen Motors	Dayton, Ohio	193,000	1,800			
Curtiss Propeller	Caldwell, N J	370 000				
Curtiss Propeller	Clifton, N J	11 000				
Curtiss Propeller	Clifton N J	25 000		(Rented)		
Curtiss Propeller	Indianapolis, Ind	400 000 (Marmon Plant)				
Hamilton Standard	E Hartford, Conn	49,000	3,700	1,761,000		
Hamilton Standard	Pawtucket, Conn	200 000				

In this effort the survey of suppliers made by the Automotive Committee for Air Defense, which lists data from 800 factories, will be used

Most of this bomber production effort on the part of the automotive industry is separate from the many other subcontracting or licensed manufacturing projects in which it is now contributing to the air defense program

Ford is completing another plant costing $21 000 000 at Dearborn, Mich where 18 cylinders double-row Pratt & Whitney Wasps will be built under a licensing arrangement of $1 per engine Ultimate production of one engine every hour is expected In conjunction with it is an apprentice school having a capacity of 2000 students. A technical school for Navy recruits is in operation at the Rouge plant. A magnesium foundry with a capacity of 110 000 pounds of castings per month is now starting operation

In addition to the greatly expanded Allison engine plant, General Motors has set up an aircraft division of Buick to build twin Wasp R 1830 engines under a licensing arrangement similar to that of Ford A newly built plant at Chicago is expected to produce 500 of these engines per month Other G M aviation projects include an aluminum foundry at Anderson, Ind , production of aircraft controls and instruments at Rochester and, of course North American's new auxiliary plant for complete production of AT-6A's and SNJ 3's at Dallas (see page 54)

Studebaker is teaming up with Wright Aeronautical Corporation to increase capacity to produce double row Cyclone engines of the 1700 hp variety, and is building a $36 000,000 plant at South Bend Complete engines under license and parts will be assembled at Wright's new 1,694,000 sq ft plant at Lockland, Ohio which will be devoted to construction of complete engines as well as to assembly Parts for Wright engines will also be built by Hudson and others Hudson will build air frame parts in addition to those for the Martin B-26 under the Knudsen plan Goodyear will also build wings and tail surfaces for the Consolidated PB-2Y3 besides the same parts for the Martin B-26 Packard will soon be building Rolls-Royce Merlin engines in a $38,000 000 plant near Detroit Briggs Body and Murray Corp are building air frame parts Nash-Kelvinator will build Hamilton propeller parts.

Day by-day other automotive companies are entering the aircraft industry as subcontractors largely through the operation of the Automotive Committee for Air Defense which is expanding in cooperation with the Army Air Corps A group of Air Corps officers, under the direction of Major James H Doolittle, has organized inspection, priorities, and production divisions to expedite the contribution of the automotive industry in the air defense production programs Not only automobile companies, but other manufacturers have become aviation subcontractors. Otis Elevator is building a new plant at Harrison, N J, to build parts for Wright engines The Iron Fireman Company, Pacific Car & Foundry, A. W Hecker, and several hundred other firms are doing subcontracting work for Boeing B-17, four-engined bombers (see page 74) These are typical of many other similar arrangements

Smaller organizations such as machine shops are turning out parts for subcontractors and primary contractors, but there is still much available machine tool capacity which is not being fully utilized. When the present program was initiated last fall the aircraft industry subcontracted about 10 percent of its work. The desirability of increasing this proportion was soon recognized by O P M officials and a tentative objective of 40-45 percent was envisioned, to accelerate the program so that it would be possible to use existing tools rather than wait for new ones With this in mind the Defense Contract Service was set up to provide a clearing house through the Federal Reserve Banks for local information on work needed by contractors and available subcontractors capable of turning it out There are 36 regional offices where technical information in defense products is available and financial advice may be obtained This organization has been somewhat slow in starting and the subcontractors in certain sections of the country are skeptical about its full potential effectiveness

Many small but experienced firms are ready and willing to speed up their production but they are handicapped by state and local legislation, insufficiently sound business management, lack of sufficient knowledge of their own financial position and productive capacity There are many differences in nondefense and defense work and it is often difficult for the small shop to adjust itself to government contracting Some primary contractors have done extensive educational jobs imparting the "know-how" to newcomers in the field (see page 76), others have feared increased production costs failure of the sub-contractors to meet delivery and quality standards, and the oft-repeated truth that "the subcontractor of today is the competitor of tomorrow" Whether the Defense Contract Service will be able to solve all these and other problems remains to be seen Perhaps more adequately staffed branch offices of O P M in important defense pro-

duction centers may be required.

While federal officials ask for seven-day work weeks, and many primary contractors are operating on that basis, there are state laws prohibiting the seven-day week which the small shop operator cannot afford to fight. California with its great percentage of work is hampered by such a law and so far the State Labor Department has refused to recognize the present situation as an emergency of sufficient magnitude to lift the seven-day restriction.

The priorities situation has been improved somewhat by authorizing primary contractors to extend priorities to subcontractors. Deliveries of strategic materials is still somewhat irregular and some production schedules are being upset by inability to depend on promised delivery dates.

The existence of all these problems doesn't mean that the program is progressing unsatisfactorily. Such maladjustment is inevitable in an expansion project surpassing in speed that of any other industry in any nation at any time. We are trying to do in two years what it required six for Germany to do, and, almost miraculously, we are doing it. The broad basic principles of the present program have proved to be correct. Details will have to be modified here and there as time goes on. We have gone far enough to be sure that the job could not have been done nearly as well by any other methods. But no matter how well it is done we must not be satisfied until we are well out of the woods. And as citizens we must resist to the utmost any attempt by politicians or theorists to modify the methods that have produced such good results so far.

Continued intensive research such as is being conducted in our airplane and engine laboratories today plus an increasingly efficient use of our magnificent resources of human ingenuity and materials, will undoubtedly maintain that surpassing quality and eventually give us indisputable preeminence in production capacity.

General Brett

(*Continued from page 37*)

tion, the country has been divided into four sections: the Northeast, Southeast, Northwest, and Southwest. Each of the four air forces, with its individual commander, is charged with defending the section in which it is stationed.

The air force is now made up of 54 groups containing 208 combat squadrons. Operating within the continental limits of the United States are 22 bombing and 17 pursuit groups.

American-built warplanes have performed meritoriously over England, Africa, the Mediterranean, Greece, the English Channel and the Atlantic. The types of planes in production and the equipment used are the result of careful studies of what is going on in Europe. They are second to none in firepower, armor and performance.

Col. Jewett

(*Continued from page 35*)

months later the number had risen to 226,172 employees.

New supplies of raw materials had to be found and tapped. New suppliers of fabricated parts had to be educated to the industry's close tolerances and inflexible standards of quality. More and more work is being subcontracted so that the aircraft manufacturers may utilize to the fullest possible extent the magnificent industrial potentialities of our country.

So the industry is striving to maintain the progress made in civil aviation during recent years. The industry is striving to assure continuance and growth of America's splendid scheduled air transportation system. At the end of this war, aviation in all its phases should play a far more important role than it has in the past.

In the future the industry will provide safer, swifter and more economical carriers for Americans in domestic and international trade or private transportation. The ingenuity and vast experience of the industry will continue to improve the flying machine—to make it ever more useful on the airways of a world at peace.

Boeing

(*Continued from page 75*)

tions of available plant equipment and personnel. It then decides upon the larger units or assemblies to be handled on the outside, and determines a general tooling program by which the outside production can be undertaken and coordinated with the Company's own "inside" production. These points are determined in collaboration with the tooling, production, manufacturing, and purchasing departments, all of which make their separate survey of the problem. The production department is then responsible for the final selection of the parts to be handled as outside production.

The preliminary selection of subcontractors is made by the purchasing department on the basis of an over-all appraisal of their plant size, equipment, location, type of previous experience, and man-hour capacity for the type of aircraft work required to be done, and by the appraisal of the firm as an organization. Boeing officials point out that this last factor, the organization, has been considered most important of all in selecting the prime subcontractors. Bids are then asked, and the actual orders are placed by the purchasing department after the production department has determined schedule requirements and has issued releases for the manufacturing work.

The production department's release will specify the quantity required, including overstock, the delivery schedule, including the minimum acceptable rate of delivery, special instructions, such as the tolerances permitted, finish specifications, tooling requirements, etc. The purchasing department cooperates with the sub-contractors to fit the work to their methods and facilities. The subject of tooling is necessarily given special consideration in order that parts produced on the outside will meet rigid Boeing specifications and will fit with other parts produced in Seattle. The production department's release, therefore, details the tools, jigs, templates, etc. to be supplied to the subcontractor and the fit and interchangeability requirements. In cases where the Boeing Company already has suitable production jigs available and they can be easily transported, these are forwarded to the outside plant. In most cases, however, the subcontractor is required to build his own jigs, using Boeing master parts as guides. For example, in tooling the Stearman Division plant for the production of Flying Fortress outer wing panels, a complete master section of the outer wing, built in the Boeing plant in Seattle, was shipped to Wichita for use in aligning all the production jigs to be set up at the Stearman plant. This master wing section was built not of aluminum alloy but of rigid steel tubes and steel plates, with all reference points and mating points located by precise methods. Similar master steel dummies of other parts were sent to other plants for aligning their jigs to insure absolute interchangeability when parts are gathered for assembly.

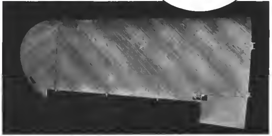
In many cases the Boeing Company has not only supplied detailed tooling for the outside producers, but has also supplied the necessary materials as well, either by shipping from material stocks in Seattle, or by asking the material suppliers to send direct to the

(*Turn to page 186*)

FAIRCHILD TRAINER M-62

The spars used in the M-62 center section are of Duramold, a wood and plastic material built to extremely close tolerances

Applies
HASKELITE DURAMOLD
Principle to Wing Construction



It is significant that the Fairchild Trainer M-62 ... built to fulfill the uncompromising requirements for military primary trainers ... utilizes Haskelite Aircraft Plywood for wing covers and Haskelite Duramold for curved center section spars. Haskelite Aircraft Plywood makes possible a wing panel covered by a single piece of plywood ... produced in curved forms ideal for best aero-dynamic construction, and eliminating all joints and seams in main part of upper surface of wing.

The consistent use of Haskelite Aircraft Plywood in ships designed to meet exacting military trainer specifications, emphasizes that whenever plywood for any structural feature is desirable, Haskelite is the unchallenged leader. Its strength-weight ratio is far higher than metal ... it readily takes curved forms suited to aero-dynamic construction ... and it requires far less time to manufacture to equivalent smoothness, install and maintain. Haskelite is superior to U S Government Specifications No. AN-NN-P511 and British Specifications 5V3.

Write our engineers for full details. Dept. AV-416.

Panels stocked on West Coast by Western Hardwood Lumber Co., 2041 E. 15th St., Los Angeles, Calif. In Canada: Railway & Power Engineering Corp., Ltd., Toronto; Montreal; Winnipeg; Hamilton; Vancouver.

HASKELITE MANUFACTURING CORPORATION
208 West Washington Street, Chicago, Illinois

LOOKS TOUGH AND IS TOUGH!

The rugged cantilever landing gear of the Fairchild M-62 Trainer is one of the reasons a fledgling pilot can learn to fly with safety in a ship that gives him big-ship "feel" and viewpoint from the very start. This unique landing gear combines wide tread, straight up-and-down travel, extreme structural strength, ease of inspection, and minimum maintenance. Result: fewer ground accidents, more pilots, *better* pilots in less time!

FAIRCHILD AIRCRAFT

Division of Fairchild Engine & Airplane Corporation
Hagerstown, Maryland . . . Cable Address "Faircraft"

Curtiss Production

(Continued from page 47)

operations which may be divided into two classes

1 Operations on machined units, such as landing gears exclusive of landing gear cowling, which are practically all performed with machine tools (Hand work is limited to handling and assembling of finished landing gear parts which must of necessity remain a manual operation, augmented, of course, by good assembly tools.)

2 Operations on sheet metal structure such as fuselages wings tail surfaces, and cowling where hand work plays a most important part particularly the joining or riveting operations This is inherent in the general nature of sheet metal construction in which machine tool equipment is not easily applicable to increased output unless the number of detailed parts can be reduced by using large stampings and the like

It is essential for purposes of comparison that this discussion be on the basis of the Curtiss engineering tooling and manufacturing procedures The airplane to be considered must also be a good production design involving the consideration of machining factors and operations which do not depend upon single purpose tooling, particularly since most operations on airplane parts involving machining can be performed on a variety of available general-use machines This requires an explanation in that there may be cases when the use of one or more machines may be reserved exclusively for a single operation This does not imply a single purpose machine tool, but rather a single use for a machine tool Then on the basis of this good production design, independent to some degree of quantity, there are not many cases where machine parts may be redesigned for a larger quantity This is because as previously mentioned if the proper care is exercised in the original design, increased quantities in general require increased output tooling

Furthermore in good production design, advantage is taken of the processes of forging and casting to the extent of eliminating the need of milling or facing operations by using normal forged and case surfaces to avoid machining These and similar applications, independent of quantity, and their consideration in design, simplify the problem of prescribing production facilities for increasing output

Naturally there are cases where machining operations justify single-purpose machine tooling, such as automatic stringer countersinking machines which will be discussed later, tube flaring equipment, face and slot grinders for landing gear links, etc Actually however, there are few cases which can be definitely termed single-purpose, such as honing, broaching, and multiple spindle drilling machines However each of these, by the proper use of a jig and fixture, lend themselves amazingly to a variety of parts One machine may be better than another as well as faster for the same type of work, hence Fay Automatics, Baker Drills, Barnes Honing Machines, La Pointe Broaches, Micromatic Honing Machines, etc

With respect to sheet metal work the distinction is more definite, since there are more cases in which it is necessary to change design for increased production recognizing, of course, that engineering technique now tends toward the design of parts that will permit alternate methods of fabricating Bulkhead blanks are designed so that they may be routed, blanked or rubber sheared Most changes in sheet metal design are made after having been released to the Shop, since fabricating difficulties are encountered, and the best methods of fabricating and design to facilitate their use cannot always be anticipated either by the Planning or Engineering Sections in original production design Furthermore, improvements in fabricating processes such as the use of steel faced wood draw dies, stamping operations, and drop hammer techniques permit the engineer more latitude in design, particularly since it permits designs of fewer detailed parts by virtue of complex, multiple, or deep draw forming operations

To demonstrate or visualize mathematically comparisons of tooling for various quantities is difficult because the element of judgment enters into a decision to a very large extent Then, too many decisions or selections of equipment are made on the basis of precedent plus a general application of "horse sense" Therefore any graphic arithmetical treatment tending to illustrate these selections is merely proof that the selection was accurate and that the proper choice of method or equipment can be achieved by purely arithmetical means except when it is desirable to plot quantities against costs to determine at what low point these methods are equal This particular phase is important in that, although it is possible to determine again arithmetically the best process or equipment to use for a known quantity, the previously mentioned economical point has further use When the economical point falls beyond the quantities to be produced it is advantageous to know by what amount the required quantities must be increased to justify, economically, the selection of the better or more expensive tool If the increase

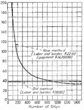


Fig 7 Point where improved equipment can be used in machining landing gear pistons

Fig 8 Machine for boring landing gear pistons

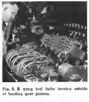


Fig. 9. A gang tool lathe turning outside of landing gear pistons.

Fig 10 Forming wing leading edge skin by the machine method. This is an application of a standard machine to perform a special function.

in the number of pieces is moderate, it is sometimes desirable, depending upon the circumstances involved, to select the more expensive tool since the quality may be better and interchangeability more practical which, in the event of an increase in production requirement or the manufacture of spares together with presupposed intangibles, will then result in a saving

Examples of production equipment selection in the form of additional charts and photographs will now be outlined In order that such graphic data be presented in its most simple form it will be presumed that the machine tools and/or jigs and fixtures for the old or hand method, for each case being considered, have been completely amortized for which reason only labor and burden is indicated. Also, it is presupposed that the new equipment cost and labor and burden will be amortized in the economical number of parts However, for other conditions the data may be adjusted or weighed to suit the requirements of the situation

The first to be considered will be the processing of stringers, particularly fuselage stringers This is a problem if properly spaced machine countersinking is done for the dimple of flush riveted skins, since the rivet holes in the skin are drilled from the stringers The original setup involved prepunching the stringers in a brake with commercial gang punches This required locating the punches with a long scale or metal tape line (the minimum spacing being limited mechanically) which was a tedious and unsatisfactory operation In addition the setting could not be exactly reproduced on subsequent future setups for that particular stringer Because of the stringer thickness with respect to the punch diameter the resulting hole had to be redrilled in addition to being machine countersunk as outlined before Therefore, it was decided to prescribe a completely automatic means of drilling and countersinking the stringers directly from the solid condition without prepunching Figure 3 indicates that the selection was economical for a quantity lower than the scheduled production It is interesting to note that the automatic machine shown in Figure 4 utilizes a master spacer bar making possible spacings limited only by structural requirements Also the spacing may be varied on any given stringer

Fig 12. Old method of forming a cable frame

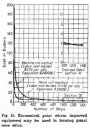


Fig 11 Economical point where improved equipment may be used in forming panel nose skins.

The new production equipment comparison for landing gear pistons is shown in Figure 5 The Baker Drill shown in Figure 6 for drilling out the solid piston forging is part of the new machine tool equipment which is also used for the landing gear cylinder Figure 7 is the landing gear cylinder chart The Barnes Honing Machine (Fig 8) and the Fay Automatics (Fig 9) are part of the new setup for the landing gear cylinder The Fay Automatics are also used for machining operations on the landing gear piston

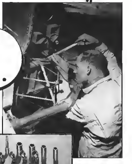
The machine method of forming wing leading edge skin is shown in Figure 10, and Figure 11 illustrates the economical point. This chart includes also, in the hand rolled method the equipment cost

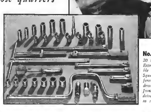
Figures 12 and 13 are a comparison of the old and new methods of forming a cockpit cabin enclosure frame The speed by which such a frame can be made in a drop hammer is very evident in the photograph, Figure 13

The selection of production and machine tooling equipment for increased quantities and the output is also very greatly influenced by space limitations within the factory itself Figure 14 shows the very orderly and efficient layout for the Curtiss Punch Press Department

In conclusion, when considering the selection of tooling and machine tool equipment for increased production quantities, it is essential that all the factors be adequately represented in the analysis such as floor space, operation planning quantities in each production run, and the influence of setup cost, also, the material handling and routing through the various process stations, and the number of shifts on which the production is based

Fig. 13. The speed by which cabin frames can be made in a drop hammer is evident.





Vought-Sikorsky

(Continued from page 63)

structures (see Fig 3 with the accompanying table) has been agreed upon

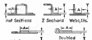


Fig.3

T	24st Alclad A Min	24st Alclad A Desired	Soft Alloys A Min.	Soft Alloys A Desired
016	3/8	1/2	7/16	1/2
020	3/8	1/2	7/16	1/2
025	3/8	1/2	1/2	1/2
032	1/2	5/8	9/16	5/8
042	1/2	5/8	5/8	5/8
045	9/16	5/8	5/8	5/8
051	5/8	5/8	11/16	3/4
064	5/8	5/8	3/4	3/4
072	11/16	3/4	13/16	3/4
081	3/4	3/4	7/8	7/8
091	3/4	3/4	7/8	7/8
102	13/16	7/8	15/16	1
125	7/8	7/8	1	1

Fig 4 illustrates a design of additional sections with their minimum dimensions When a row of spotwelds is required to complete a length of a straight edge, such as the trailing edge of a flap, (See Fig 5) it is sometimes desirable to extend one of the sheets into a bent up angle to minimize warping The angle is then trimmed off after welding to the desired dimension.

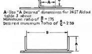


Fig 4

Thickness	"A" Less Than 2"	"A" Greater Than 2"
	"B" (Minimum)	"B" (Minimum)
016	7/16	15/16
020	7/16	—
025	7/16	—
032	9/16	—
040	9/16	—
045	11/16	—
051	11/16	—
064	11/16	—
072	11/16	—
081	11/16	—
091	11/16	—
102	15/16	—
125	15/16	15/16

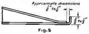


Fig.5

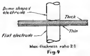
As for panels, large flat panels containing many spotwelds are subject to buckling and often must be rolled after welding for straightening The desired design condition for minimum buckling is shown in Fig 6, where the stringers follow a moderate curve.

Rolling for spotwelding is done in order to iron out buckles produced by welding and to increase the overall strength. All of the necessary rolling, however must be performed immediately after welding A photograph of the rolling machine is shown in Fig 7.

Thickness Ratio of Material

Referring again to the thickness combinations, it can be said that any ratio between the thickness of two sheets can be satisfactorily spotwelded provided that the total thickness does not exceed the total to be spotwelded Also, the thinner of the two sheets must be in contact with the dome shaped electrode as is illustrated in Fig 8 However, where a flush surface is required on the thinner sheet, accomplished by having this part in contact with the lower electrode the thickness ratio should not be greater than two-to-one (See Fig 9)

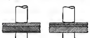
Any thickness ratio
Fig 8



Max thickness ratio 2:1
Fig 9

As for other combinations, the spotwelding of three or more thicknesses is not generally recommended Fig 10 indicates a readily permissible condition with the thickness of the two outside sheets equal or nearly so However, careful consideration should be given before such a combination is used Fig 11, indicates a condition on which it is very difficult to get satisfactory welds

Possible
Fig 10



Impossible
Fig.11

Strengthening of Spotwelds

In general it can be said that spotwelding should never be used on an assembly where any appreciable tension load will be applied to the spots As for shear loads, the minimum ultimate of shear strengths we use for the more commonly used alloys are shown in Fig 12

Thickness of Thinnest Sheet	Minimum Ultimate Shear Strength 24st Alclad	3S½H	52S½H	53SW or 53ST
016	120	55	100	100
020	165	75	130	130
025	220	100	170	170
032	310	140	240	240
040	430	190	340	340
045	520	225	420	420
051	620	270	510	510
064	830	390	720	720
072	950	470	850	850
081	1080	570	1000	1000
091	1210	690	1150	1150
102	1320	800	1320	1320
125	1450	1000	1610	1610

Values below dotted line for reference only
Fig 12

In practice a minimum of two spotwelds is used on all assemblies as single isolated spotwelds may be subjected to torsion as well as shear

(Continued from page 176)

new subcontractors portions of the materials which Boeing already had on order. In this way the outside producers have taken advantage of Boeing's early placement of material orders

The Boeing purchasing department has perfected a thorough-going system for following up the work of subcontractors after orders have been placed, to avoid, as far as possible, the chance of bottlenecks developing unexpectedly in any particular item that would affect the master production schedules in the main plant. Progress reports are required from all the vendor companies and a file is diligently maintained showing the status of all outside production parts. The subcontractors are notified each week of the parts and quantities which the Company expects to receive from them the following week

To insure that the segments of the Flying Fortress coming together from various parts of the country all measure up to the high standards which Boeing sets for its own shops, a rigid system of quality control has been set up to govern all the subcontractors' work. This begins with the detailed specification, which is drawn up with great care. In the case of the larger subcontractors, Boeing representatives are on the scene not only to check the work as it progresses, but also to offer suggestions and assistance to the subcontractor

After the parts are finished and shipped to Seattle, they pass through a careful "receiving" inspection before they are admitted to the storage racks and approved for the Flying Fortress production lines

New Two-Control Plane

(Continued from page 137)

damaged brace can be done in the field by undoing the fastening nuts from inside of the plane and inserting a new member, the fabric covering being held away from the fuselage structure by four sheet aluminum alloy fairing strips on each corner

The cabin seats two people with a luggage space behind the seats. A door is located on each side of the cabin with a foot step on the landing gear strut

The landing gear is attached to the fuselage by means of three bolts which can be detached from the outside of the ship. A double acting shock absorber Oleo is used which has a travel of six inches. The nose wheel attaches to the fire wall and has been built to be easily removable

The engine mount uses vibration dampening mounts on top of which the engine "floats." The cowl is completely free from the engine and mount, allowing the engine to turn idle without moving the cowl. Power is supplied by a 75 horsepower geared Lycoming engine

The wing is built up on a "D" section leading edge spar for the first 35 percent of the chord. On the back of this is a shear web made up of a sheet of aluminum alloy with angles riveted on the ends. The section behind the spar is constructed of built up ribs with cloth covering. At the rear of this section are attached the flaps next to the fuselage and the ailerons outboard from these. The flaps and ailerons are made with a rounded nose of sheet aluminum alloy to which are attached built up ribs, the assembly being cloth covered. The fabric on the main section of the wing is attached in a unique fashion by means of a piece of wire running along the top and bottom of the shear web, and can be done in a very short time

The stabilizer is made like the "D" section of the wing, being constructed of aluminum alloy ribs with aluminum alloy sheet covering. The elevators are made just like the ailerons and are cloth covered. The vertical fins are built up of tubing with former ribs and are cloth covered.

One of the features of its easy maintenance is that all the parts of the plane have been numbered so that for replacements the owner has only to send the part number back to the factory. The specifications for the ship are as follows

Specifications

Span	31 ft. 5 in.
Overall length	22 ft.
Overall height	8 ft. 8 in.
Cruising speed (5000 ft.)	92 m.p.h.
Landing speed	48 m.p.h. min 50 m.p.h. max
Range	425 miles
Horsepower	75 hp. Lycoming (geared)
Gross Weight	1250 lb.
Weight Empty	890 lb.
Baggage	45 lb.
Gasoline Capacity	20 gals.
Oil Capacity	5 qts.
Wing area	590 sq. ft.
Tail area	16.6 sq. ft. stabilizer 8.3 sq. ft. elevator 25 sq. ft. (total) fins
Wing loading	11.1 lb./sq. ft.

Spot Welding

(Continued from page 63)

Design of Spots

The spotweld diameters listed in Fig 13 are the approximate diameters of the depression on the dimpled sheet. In making these welds it is necessary to provide some means of holding assemblies together prior to and during the operation. This may be done by jigs or fixtures or more commonly by screws or snap fasteners. The screws or fasteners are subsequently replaced by rivets. In general these clamping screws are fastened to the ends of the stringers and spaced approximately one and one half feet apart. A typical use of this method of clamping is shown in Fig 14

Thickness of Dimpled Sheet	Approx Spotweld Dia in Inches	
	Alc 24st	Softer Alloy
.016	1/8	5/32
.020	9/64	11/64
.025	5/32	3/16
.032	5/16	7/32
.040	7/32	1/4
.045	15/64	17/64
.051	1/4	9/32
.064	9/32	5/16
.072	19/64	11/32
.081	5/16	23/64
.091	11/32	3/8
.102	23/64	13/32
.125	3/8	7/16

Fig 13

Holes for clamping screws shall be provided on each piece and indicated on the drawing. Spacing shall be as required by design

Fig 14

As to where the spots go, a definite procedure should be followed in spacing the spotwelds and their minimum distance in from the edge of the material. Fig 15 indicates a method of determin-

Single Sheet Thickness	Minimum Edge Distance	
	Alc 24ST	Soft Alloys
016	3/16	3/16
020	3/16	3/16
025	3/16	1/4
032	1/4	1/4
040	1/4	5/16
045	1/4	5/16
051	5/16	5/16
064	5/16	3/8
072	3/8	3/8
081	3/8	7/16
091	3/8	7/16
102	7/16	1/2
125	9/16	11/16

(Turn to page 229)

Martin Processes

(*Continued from page* 53)

called stiffeners The spar tapers from the thickness of the wing at the fuselage to the narrow end of the wing at the base of the wing-tip.

To form the spar on the B-26 fixtures, the stiffeners are inserted and clamped into guides across the fixture, each guide being exactly the length of its stiffener, all of which are different lengths. Over the stiffeners are laid the sections of web, pre-cut by machinery in the shops Small holes in the web sections fit locator pins in the fixture Then the extrusions, a cross-section of which is the shape of a slanting T, are placed along the steel guides as a sort of frame for the assembly, the leg of the T overlapping the web

But where to drill? The stiffeners are hidden, and each hole must be exactly the right size in exactly the right place This is solved by the colored drill template, or pattern, which is just the shape of the spar It is painted orange, green, yellow, red and blue, and when the pattern is fitted over the assembly, all of the case-hardened-steel-lined guide holes not only show exactly where the holes are to be bored through the assembly but the size of bit for each hole is determined by its color

For example, the driller, operating a traveling drill press mounted on rails on the table, drills with one bit in all of the holes in the orange sections When he comes to green or yellow or red or blue, he knows immediately he must change drills Only a color-blind man could reasonably make a mistake

This is simply typical of the manner in which all sub-assemblies are made by methods that are all but foolproof It is much the same story when the completed sections move into the major-assembly fixtures to join others, and when each major sub-assembly—a nose section, center section, tail section after-tail section or wing—is put into the splicing fixture to meet the next completed component, there is no question of a fit, the bolt holes meet each other to within thousandths of an inch

Such simplification extends throughout the entire Martin plant, and to insure that every means be found to make the work easy, and adaptable to comparatively inexpert hands, several hundred men of the leader class and higher are banded together in Work Simplification Conferences. No detail escapes their watchful eyes

By such methods will even the highly complex military airplane, ever a product of high skill, succumb to the efforts of lesser dexterity

These three photographs show how Martin makes a center wing spar section for a B-26. Into this jig are placed stiffeners.

Then the extrusions forming the upper and lower members, the sheetmetal web and additional stiffeners are laid. The forging at the corner in the foreground grasps the outer wing spar at the base and acts as a shoulder blade It is the largest aluminum alloy forging yet produced.

A traveling drill press mounted on rails is used for drilling all holes through extrusions forging, web and stiffeners

Wanted Quick:

Half a million sq. yds. of Airport Runways?

Complete the job in 30 working days with **CONCRETE**

There is practically no speed limit on runway construction when you specify concrete. Present experience on airport and highway jobs shows that up to 17,000 sq. yds. of 8-6-8 concrete can be placed daily by two 34-E dual-drum paver outfits working two shifts, or with comparable ready-mix facilities. Figure what that means in terms of a half-million square yard project:

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In 30 working days—Bring on the big ships! The 500,000 sq. yd. airport is *paved,* big areas in use

Concrete materials and equipment are available. Speedy construction with concrete is combined with the advantages of low maintenance . . . all-weather safety . . . high visibility by day or by night . . . lowest first cost for a given load-carrying strength . . . *dependable load capacity for the big planes, today, tomorrow.*

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FROM 0 to 1700 RPM in a fraction of a second! That's what happens every time your tires hit the runway at 45 miles an hour. It takes an extra-tough, super-strength tire to stand up under that kind of punishment for landing after landing. And that's why so many fliers, plane manufacturers and airlines are changing to Firestone Safti-Built Airplane Tires

No other tire made gives you the strength, safety and long wear made possible by the patented Firestone Gum-Dipping process and other exclusive construction features. Get the facts about Firestone Safti-Built Airplane Tires today. For full details write The Firestone Tire and Rubber Company, Akron, Ohio, or Los Angeles, California

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When you have a demonstration flight in Luscombe's new all metal Silvaire Master, note that it, like all other Luscombe models, is equipped with Firestone Sky Champion Tires, wheels and brakes to assure happy landings

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Safti-Built **TIRES ★ TUBES WHEELS ★ BRAKES**

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THE ONLY ONE IN '29

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THE famous Aeronca C-2 Scout, which introduced the Aeronca line in 1929, was the first sound, light plane ever offered to America — the first plane to bring the pleasure of safe, dependable flying within the reach of the average income.

And now, out of 12 years' experience and leadership, comes the finest light plane ever built . . the new Aeronca Super Chief . . our masterpiece. Built into this smart, sturdy craft are all the refinements, improvements and safety features that a flier could possibly ask for. Before you buy any plane, see and fly the Aeronca Super Chief. There is an Aeronca dealer near you who will gladly give you a FREE demonstration flight.

AERONCA GIVES WINGS TO THE WORLD

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ACCEPTANCE...

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When you are considering propellers, consider—

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High Pressure

Integral Unloading Valve

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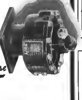
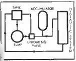
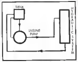
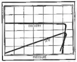




Conventional Hydraulic System



Dowty Liveline System



Liveline Performance Characteristics

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Full pressure and delivery available immediately a control valve is opened.

No hysteresis on cut in. Automatic cooling when cut out.

Small power input when cut out

Delivery—1 G.P.M. per 1000 R.P.M.

Cut-out pressure—2000 lbs. per sq. in. or lower to suit system.

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DIVISION OF GENERAL MOTORS CORPORATION

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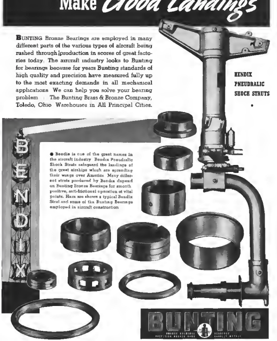
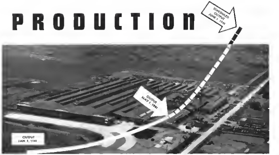


● Bendix is one of the great names in the aircraft industry. Bendix Pneudralic Shock Struts safeguard the landings of the great airships which are spreading their wings over America. Many different struts produced by Bendix depend on Bunting Bronze Bearings for smooth positive, anti-frictional operation at vital points. Here are shown a typical Bendix Strut and some of the Bunting Bearings employed in aircraft construction.

BUNTING

BRONZE BUSHINGS
PRECISION BRONZE BARS
BEARINGS
BABBITT METALS

PRODUCTION



Beginning on January 2, 1941, new buildings and new production machinery (provided under the terms of an Emergency Plant Facilities Contract) have been placed in service at BEECHCRAFT, unit by unit, immediately upon their completion or installation. By taking advantage of the partial usage of new facilities, production has risen swiftly and steadily, and as of May 1st stands at a level approximately nine times the average level maintained during the fiscal year 1940. It is anticipated that this May level will be doubled by July 1941 and quadrupled by November 1941.

BEECHCRAFT is meeting its predicted schedule of deliveries and both management and labor are exerting every effort to surpass the schedule set up for the future.

BEECHCRAFT'S new facilities are practically all completed and in use, including its own airport which measures one mile by one-half mile. The effect of the utilization of these complete facilities will be demonstrated at an early date.

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BEECHCRAFT

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From the selection of the steel that enters our furnaces until your tubes are shipped - vigilance is the watchword.

Constant inspection by eye and instrument while your tubes are undergoing every process, plus the most rigid final inspection, assure you the uniform top quality for which OHIO SEAMLESS Steel Tubing is famous.

During the past year this series of pictured trips into the home of OHIO SEAMLESS at Shelby, Ohio, the birthplace of seamless tubing in America, has described to you briefly the experience, skill and vigilence of our craftsmen: also, the technical and production facilities of our modern plant.

Piercing, rolling, reeling, sizing, pickling, drawing, annealing and straightening are only the mechanical processes. Physics, chemistry, metallurgy and their specialized branches also enter into today's demands for tubing. In these we are completely equipped and justly proud. However, our greatest asset and your best guarantee of quality is the experience, sincerity and loyalty of craftsmen in a plant where to everyone "Vigilance is the watchword".

OHIO Quality is constantly under test in the laboratory

Each tube is inspected red hot seconds after piercing

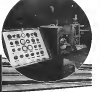
"OHIO" QUALITY

32 Years Continuous Production Under This Trade Name

The OHIO SEAMLESS TUBE CO.

OHIO SPECIAL QUALITY

Shelby, OHIO



Magnetic testing finds the slightest hidden flaw

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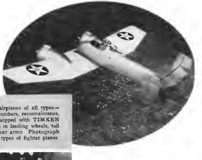

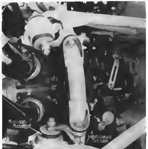
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TO GUARD OUR CIVIL NECESSITIES

FOR SECURITY "BEHIND THE LINES"

In our urgent production for National Preparedness we must not overlook essential protection for our civil necessities. We must defend both from "within" and from "without" to insure our safety. Light planes are a vital necessity to achieve this security.

PATROLS—Light planes are most efficient for patroling and guarding our forests pipe lines, water systems, power lines railroads, etc.

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AUXILIARY MILITARY SERVICE—For patrol scouting observation photography and messenger service "behind the lines," the light plane provides many advantages over heavier planes in auxiliary military service.

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For these and hundreds of other vital defense jobs, America is dependent on light planes The light plane industry already has the production facilities and the capacity to handle this essential task

★ Write for a new free catalog of the modern, low-priced Taylorcraft airplanes and information on flying instruction.

Important Advantages of the Light Airplane in Defense Service

Light planes can be landed on roads small fields beaches and many places inaccessible to heavier planes.

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Light planes can be flown at "tree top" heights for easy observation and at low speeds impossible with heavier planes.

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The average person can fly a Taylorcraft after only 8 hours instruction.

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Light planes provide the lowest possible flying cost

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"WHERE RESISTANCE TO TORQUE FORCES must be low," says Mr Z Soucek, Vice President of Brewster Aeronautical Corporation, "and where weight and size of both bearings and housings must be kept at a minimum and the installation freed of the need for replacements, we use Torrington Needle Bearings."

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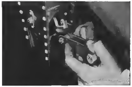

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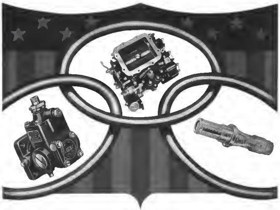

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★ AIRPLANE DIVISION ★

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★ Pictured on this page are a number of Aviation Accessories ★ Knowledge and understanding of Air Corps and Navy Requirements and quality manufacturing are outstanding features of the hundreds of Weatherhead parts being shipped to aircraft manufacturers.

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Flexible hose assemblies—low medium, and high pressure—manufactured to "AN" Specifications

Pipe fittings—new "AN", NAF, and Air Corps types

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FILTERS OF THIS TYPE ARE AVAILABLE FOR EASY FITMENT TO EXISTING AIRCRAFT

CONTACT!—turn into the wind—and away goes the first silver squadron Up into the bowl of the sky, wing-tip to wing-tip—up and away, almost as one 'plane, swift into the eastern sky till they seem but glistening pin-heads stuck in an azure band Below on the sun-grilled earth great billowing clouds of dust float slowly across the airfield

Dust—just dust But a powerful and dangerous enemy Our only weapon is filtration, and if full efficiency is to be maintained, if breakdowns are to be avoided and engine-life prolonged—then that filtration must be **perfect.**

To-day, such filtration is no longer just an idea Long months of research in the VOKES laboratories have made it an actual, proven fact These VOKES filters, both for air and for high and low-pressure oil systems, are designed **on an entirely different principle of filtration.** Their efficiency—tested and proved under the strictest conditions—is 99 9% (filtration down to particles 0 00004 in diameter) This indeed is perfection Human endeavour can go no further Here at last is a guarantee of constant air and oil-purity no matter the conditions of service

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TRIPLE DEFENSE *Against Fire*

INSTANT SMOTHERING OF FIRE BY CARBON DIOXIDE...
A Cardox Fire Extinguishing System pipes low temperature carbon dioxide to any combination of hazards, releases it automatically in large volume, and freezes out fire instantly The rapid cooling effect not only slows formation of combustible gases but also lowers temperature below re-kindling point.

...IN VOLUME TO MEET ANY HAZARD...
An exclusive Cardox development—capacity of 1/4 to 125 tons or more for liquid CO_2 in centralized refrigerated storage for release through a simple piping system to any hazard Release of CO_2 may be by any combination of manual or automatic controls Because the temperature of the CO_2 in storage is zero° F, its ability to absorb heat from the fire zone is several times that of the same gas stored at atmospheric temperatures

...WITHOUT DAMAGE BY THE EXTINGUISHER
CO_2, an inert gas, causes no damage to production equipment and buildings After-fire clean up and production outages are held to minimum Also the tremendous cooling effect limits not only the damage caused by flame but that caused by high temperatures.

● A Cardox Fire Extinguishing System offers practical assurance that fire—accidental or incendiary—shall not needlessly impede production or weaken morale The essence of a Cardox System is SPEED—unsurpassed speed in preventing fire's damage and spread—accomplished by the release of fire-smothering CO_2 in unprecedented volume and at rates that instantly overwhelm terrific bursts of flame

Not all big fires start as small ones For example, where volatile substances are involved the first fire in a room may be large and widespread Cardox, by creating an atmosphere in which no fire can exist, extinguishes a large fire as readily as a small fire

Because Cardox stores pure, dry, liquid CO_2 under controlled temperature these systems can be much more positively engineered than is usual in dealing with fire Such factors as pressure, rate of flow, and expansion being known, Cardox engineers can set up super-human controls for automatic fire extinguishment and show uniform performance These feature a timed sequence of events including pre-discharge alarm, timed discharge at one or more single or overlapping hazards, and re-set for remaining hazards

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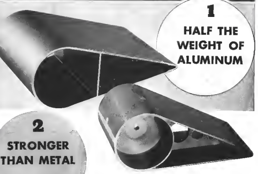
Lighter, Stronger Wing Tabs of FORMICA!



1
HALF THE WEIGHT OF ALUMINUM

2
STRONGER THAN METAL

3
NO CORROSION

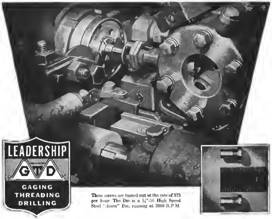
FORMICA plastic wing tabs developed recently to take the place of metal tabs are shown in cross section in the photograph to indicate the methods by which the unusual strength of the construction is secured.

These plastic tabs weigh half as much as the lightest practical metal; they are not subject to corrosion or deterioration of any kind; the co-efficient of thermal expansion is very low and dimensional change is negligible. They hold their finish.

Formica engineers will be glad to discuss the production of wing tabs for your requirements.

FORMICA

THE FORMICA INSULATION CO., 4628 SPRING GROVE AVE., CINCINNATI, O.



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GTD
GAGING
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These screws are turned out at the rate of 375 per hour. The Die is a ¼"-56 High Speed Steel "*Acorn*" Die, running at 2000 R.P.M.

"Acorn" Dies are Super Accurate

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"*Acorn*" Dies offer every branch of the aviation industry the same fast, accurate, low cost threading that instrument makers have long appreciated. "*Acorn*" Dies and holders are regularly obtainable for all size threads from 0-80 machine screw to 1½"-12. They work equally well on fixed or revolving spindles. Ask for complete data.

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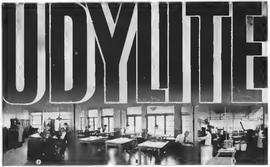
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To Prepare You for Leadership in Commercial Aviation—

PARKS Offers an Approved COLLEGE EDUCATION Majoring in Aviation

Above — Students at entrance to one of the class room buildings on the Parks Campus

At right — Adjusting propeller blade pitch in the shops

PARKS AIR COLLEGE was founded August 1, 1927. Has enjoyed Federal approval longer than any other aviation school

Is accredited in its Aeronautical Engineering School by the Illinois Superintendent of Public Instruction.

Is accredited by the United States Office of Education of the Federal Security Agency

Graduates are qualified educationally for appointment as flying cadets in the U. S. Army Air Corps and for flight training in the U. S. Naval Air Reserve.

Has a capacity enrollment of 300 commercial aviation students, 216 U. S. Army Air Corps flying cadets and 48 enlisted mechanics

Has its own airport with a school plant of 25 buildings devoted to school purposes entirely, also two fields of 368 acres and 96 acres for military flight training

Has a faculty of 62, each especially qualified for his particular field of instruction

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AMERICA'S SMOKE of battle belches forth from the chimneys of tank and truck plants, from the factories of motor manufacturers, machine tool builders, weavers of khaki cloth for a million men. From tens of thousands of plants of all kinds!

This world has never known the likes of it for sheer power and volume and speed!

And one reason the whole thing works so beautifully is the Industrial Distributor, the man who holds down industry's "life-line." For behind the scenes . . . behind this "world's greatest production show" . . . is a never-ending stream of supplies, of parts, of vital tools that *keep* industry "on production." The Industrial Distributor *feeds* industry. He is able to make deliveries from stocks on hand in half a day that might take a month, two months, or more, direct.

Nowhere else in this wide world will you find a counterpart for him. He fills a function peculiar to the American industrial system.

Over the years hundreds of manufacturers have learned they could serve their customers better and faster and more economically through the Industrial Distributor. But just suppose their production schedules, now so compactly geared to the known requirements of a few hundred distributors, should have to be adapted to the unknown needs of tens of thousands of users! Think of the chaos!

And what about those tens of thousands of users? They, too, have learned to depend upon the Industrial Distributor. For materials, for tools and supplies—*what* they want, *when* they want it. No wonder one of this country's best known names in the machine tool field buys every last item it can, *exclusively* from the Industrial Distributor. No wonder one of our leading builders of bombers does exactly the same! No wonder, as you go through industry, you find plant after plant profiting by the identical policy.

What a man this Industrial Distributor is! Able to anticipate industry's needs, knowing his territory as he does, he ranks high in ability and low in cost as a salesman . . . simply because he operates so effectively as a purchasing agent for his customers. He knows *his* business and he knows enough about the business of his customers to act as trouble shooter and to pass along useful ideas. Think of the *flexibility* of distribution he makes possible. The *economy* of distribution he creates!

Long before our Defense Program was out of first gear . . . In fact, long before any Defense emergency existed . . . the Industrial Distributor was handling this ticket of work on a solid schedule of working hours, fifty two full weeks a year. Years ago he learned to look emergencies in the face—and lick them! When someone kicked over the red lantern, and the Defense rush was on—he was ready for it!

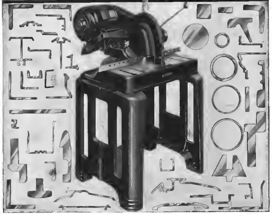
It was *his kind* of job. He has always worked best under pressure. He's known it all his business life. So he simply rolled up his sleeves and went right on *delivering* . . . driving himself even harder, to serve.

Yes, every hour of every working day he's "*delivering the goods*" for plants from coast to coast. He's writing his own story . . . in sweat, not in words. He doesn't hit the headlines, and he's too busy to take any bows. But for our money, he's "All-American" on this great Defense team!

MILL SUPPLIES *The Magazine for Industrial Distributors and Their Salesmen*

NEW YORK

New Cut-Off Machine for Non-Ferrous Metals



New DELTA Machine Cuts Non-Ferrous Metals with POLISHED SMOOTHNESS

The photograph above shows some of the actual shapes and sizes handled by the new Delta Cut-Off Machine. This remarkable unit is designed especially for cutting copper, brass, aluminum and other non-ferrous metals. It is equipped with a special high-speed steel blade and oiling device which feeds cutting oil to the blade. It leaves the cut perfectly smooth, thus eliminating additional finishing and polishing operations. Here is a powerful, accurate machine made available at a fraction of the prices customarily charged for machines of this type.

CUTS THESE MATERIALS—SOLID SECTIONS: Soft Brass up to 1½" diameter; Half Hard Brass, up to 1½" diameter, Aluminum, up to 1½" diameter, Aluminum Extruded Sections, up to equivalent of 2 sq. in.; Copper up to 1½" diameter or equivalent of 2 sq. in.; Magnesium (Dow Metal), up to 1½" diameter. Micarta and Similar Rods up to 1½" diameter. TUBULAR SECTIONS: Soft Brass, Hard Brass, Aluminum, Copper, Dow Metal, Micarta and Similar Tubing. All up to 2" diameter.

The Delta Mfg. Co. also makes the complete line of Delta 14" and 17" single and multi-spindle drill presses—in use in many thousands of plants, large and small, all over the world.

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AMPCO METAL, INC.
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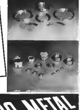
Illustrations to the right show typical aircraft parts made from AMPCO METAL—landing gear parts, propellor hub bushings, cones and attaching nuts, engine bearing levers and cam retainers.



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* one 8 pt socket

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CANNON Plug Assembly conforming to Army-Navy Specification AN9534 of Aeronautical Board. Polarity shown is designed for 110 V service

Cable Connectors for Aircraft Service

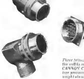
The CANNON line of Multiple-Contact Electrical Cable Connectors embraces the greatest variety of fittings for this service produced by any manufacturer.

Less than ten years ago CANNON pioneered the first aircraft plug assembly to permit the installation or removal of motors without soldering or unsoldering countless cable wires. New uses led to almost endless variations until today CANNON PLUGS are listed under more than 8327 catalog numbers covering the field of Aeronautics, Sound, Geo-physical Research, Television, Instrument-Control on Ships, Laboratory Panels and Commercial Power.

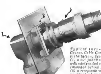
In the aircraft field, CANNON concentrates on two principal lines—the "K" series and the "A-N" series. The "K" series is the refinement of the earlier fittings pioneered by CANNON for aircraft. The "A-N" line is CANNON'S interpretation of the composite designs of the U. S. Army Air Corps and the Bureau of Aeronautics, Navy Department. These designs are in conformity with Specification AN9534, Amendment 3, as prepared by the Permanent Working Committee of the Aeronautical Board.

More than 25 years of manufacturing experience is behind every CANNON product. Experience, specialization, quality and service have won for CANNON CONNECTORS recognized leadership in a world market.

We issue a series of illustrated bulletins which may assist in solving your "Plug Problems." Bulletin "K" and Bulletin "A-N" list plugs for aircraft. Bulletin "P&O" lists plugs for "Sound." When requesting bulletins please specify requirements.



Three fittings illustrating the well-known "K" line of CANNON Cable Connectors precision built of lightweight aluminum alloy for aircraft service



Typical thru-panel Cannon Cable Connector installation, featuring (1) a 90° junction shell with solid conduit attached (mounted behind panel) (2) a receptacle mounted on front of panel and (3) a straight cord connector flexible conduit attached (coupled to plug).

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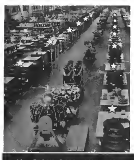


Spot Welding

(Continued from page 186)

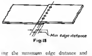


Fig. 15

ing the minimum edge distance and its accompanying table shows the minimum allowable edge distance to the edge of the sheet. This applies specifically to lap joints and seams. For angles, channels and etc, the spots are centered on the flange. Single and double row spots for aluminum alloys are standardized and tabulated in Fig 16 and pictorially indicated.

Condition	Spotweld Spacing		
	*Secondary Structures	*Primary Structures	
		Below .051	Above .051
Single Row "S"	[illegible] ± [illegible]	[illegible] ± [illegible]	[illegible] ± [illegible]
Double Row "S"	1 ± [illegible]	[illegible] ± [illegible]	1 ± [illegible]
Nominal Distance Between Rows "D"	[illegible]	[illegible]	[illegible]

* As determined by structures design

It is not desirable to call for spotwelding on an assembly which consists primarily of a riveted construction However, there is no set rule for the minimum number of spots to make the process worthwhile, but certain types of sections used in the construction of the airplane should be kept in mind for the efficient utilization of spotwelding These sections are illustrated in Fig 17 which is shown at the end of the article.

Shop Control and Testing Procedure

At Vought-Sikorsky where this spot welding technique was formulated a definite procedure has been installed Machine settings for each combination of materials and thicknesses used in production are posted on or near each welding machine in the shop The machines are adjusted for each job by a man thoroughly familiar with both setup of electrodes and adjustment of welding controls This done tandem double spot shear specimens are made and tested in a portable testing machine to determine the shear strength of the spotwelds Minimum strength requirements must be met for each thickness of material When the strength indicated by the test is satisfactory, an inspector checks the machine setting and O.K.'s it for the production job (See Fig 18)

Shear tests are pulled once each two hours of continuous operation, after any change in setup of machine and at the beginning of each shift In addition, samples made on a setup for welding a typical structure are cross-sectioned and etched on an average of once a day to check for spot soundness.

VOUGHT SIKORSKY AIRCRAFT
SPOTWELDING DEPARTMENT
PRODUCTION TEST RECORDS

DATE 3-26-41
MACHINE NO. 3
NOTES 8 c-rocker-arm type machine

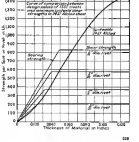
PART NUMBER	MATERIAL	[illegible]	PRESSURE		HEAT	[illegible]	[illegible]	STRENGTH	TIME		OPERATOR	[illegible]	INSP.
			[illegible]	[illegible]					A.M.	P.M.			
54-080	alc 24ST	.040-.045	700		26,000	[illegible]	[illegible]	1000 lbs (2 spots)	10.00		7	[illegible]	G.G.

Sample of Production Test Record of spotwelds which is kept on record for a certain length of time and is made out at specified intervals.

Here is an extreme angle setup necessary for welding aluminum alloy tube This is not a design to be strongly recommended for spotwelding However, on thin materials it is still less expensive than riveting

This shows a typical test table with rack for all thicknesses of samples and testing machine for determining the strength of the double spot specimens (lower left).

Each spot welded assembly is given a final check by an inspector before leaving the department for spacing, edge distance, surface cracks, etc The shear specimens may be any standard size but actually are made from two strips 1-in x 4-in overlapped 1½ inches



A WORD ABOUT DELIVERIES

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Fully conscious of its obligations as the leading producer of seaplane floats, the management of Edo Aircraft Corporation is taking every possible step to meet the vastly increased demand for both military and non-military float gear. To this end an extensive program of expansion in engineering and production personnel and plant facilities has been successfully completed in record time.

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NON-MILITARY FLOATS—Orders for private and commercial floats, particularly in the light plane field, have been unusually heavy this year. The temporary lag in delivery of some models is due wholly to shortages of critical defense materials which have been under order since last fall. Assurances have been received that these materials will be forthcoming, so that the resumption of normal production of non-military floats is in immediate prospect

Two of Edo's three modern plants totaling 132,000 sq. ft. of floor space

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(Also synthetic covered)

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IN THE 'PLANE

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Oil Filters

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Lt. Col, General Staff Corps, U. S. Army
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SHEET STEEL
NON-FERROUS METALS
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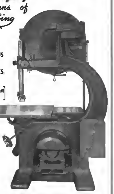
[See Chart Below]



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Built by Sawing Machinery Specialists

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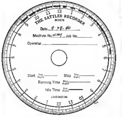
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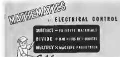

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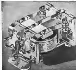

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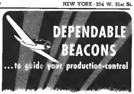

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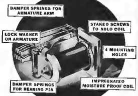
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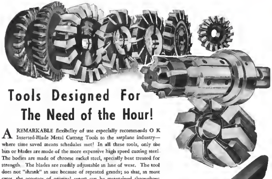


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